NATIONAL AIRSPACE SYSTEM PLAN

HEARING

BEFORE THE

SUBCOMMITTEE ON AVIATION

OF THE

COMMITTEE ON COMMERCE, SCIENCE, AND TRANSPORTATION UNITED STATES SENATE

NINETY-SEVENTH CONGRESS

SECOND SESSION

ON

REVIEW OF THE FEDERAL AVIATION ADMINISTRATION'S NATIONAL AIRSPACE SYSTEM PLAN (NASP) WITH PARTICULAR EMPHASIS ON THE FIRST FIVE YEARS OF THE PROGRAM

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NATIONAL AIRSPACE SYSTEM PLAN [NASP]

THURSDAY, JUNE 24, 1982

U.S. SENATE,
COMMITTEE ON COMMERCE, SCIENCE, AND TRANSPORTATION,
SUBCOMMITTEE ON AVIATION,
Washington, D.C.

The subcommittee met, pursuant to notice, at 9:40 a.m., in room 235, Russell Senate Office Building, Hon. Nancy Landon Kassebaum (chairman of the subcommittee) presiding.

Staff members assigned to this hearing: David M. Kirstein, staff counsel; and Charles M. Barclay, minority staff counsel.

OPENING STATEMENT BY SENATOR KASSEBAUM

Senator KASSEBAUM. The hearing will come to order.

We are without microphones at this point. They are hoping to correct that, certainly, I hope, soon, because I think it will make it difficult to hear the witnesses, but I think I will go ahead with my opening statement. Then we will see if those in the back of the room are having trouble hearing testimony. I think that is the important part of it, and we may have to make some different arrangements if this is a problem.

It is a pleasure to welcome you this morning, Mr. Helms. I would like to say that I think this is an important hearing. This is an extremely important plan. I feel on occasion there have been misunderstandings, and I appreciate if those who have come this morning to help us better understand it can help us find some answers.

We held a hearing last month on the proposed ADAP legislation, which included a general overview of the National Air Space Systems Plan, which will largely be funded through the Airport and Airway Trust Fund.

Today, we will focus more attention on the NASP. We are particularly interested in those aspects of the plan which will be implemented during the first 5 years. I understand that of the 97 specific projects contemplated, 49 will be completed during the first 5 years, and all but a few will be started during this period.

Because of the importance of this initial phase, we want to be sure that the plan is needed, that the early programs move us in the right direction, and that there is sufficient flexibility to deal with the unknown variables that will surely crop up in the years ahead. Virtually all of those who have reviewed the plan have been impressed by the effort of you, Administrator Helms, and the staff of the FAA. I think it has been an extraordinary effort. I think it has moved us far, far ahead in the future of air space planning.

There is also general agreement on the need to modernize the system, and that the process should begin now.

However, as with any program of this size, questions have been raised about both the scope and timing of the various projects. Some issues relate to the overall concept, such as the proposal to require transponders in an aircraft that operates above 6,000 feet by the turn of the century. Others deal with some of the technical aspects of the plan.

Our purpose today is to both clarify what is planned and to explore the issues that have been raised. This will enable the subcommittee to determine whether any further action might be needed before we move forward with the ADAP legislation.

I would like to assure everyone here today that we are going to move expeditiously on the ADAP legislation, and it is my hope, and I do contemplate that it will be passed by the end of July.

It is a pleasure to welcome you this morning, Mr. Helms.

STATEMENT OF HON. J. LYNN HELMS, ADMINISTRATOR, FEDERAL AVIATION ADMINISTRATION

Mr. HELMS. Thank you, Madam Chairman and members of the committee.

Recognizing we do not have microphones, I will speak slower in the hope that the attendees can hear my testimony as given, Madame Chairman, if that is satisfactory.

Senator KASSEBAUM. Thank you.

Mr. HELMS. I welcome the opportunity to appear before you to discuss the National Airspace System Plan. As you know, I announced this plan for a rather sweeping modernization in January, in order that concerted study and comment by all elements of the aviation community could be held before final approval of the Congress. It has now been in the public domain for some 5 months, long enough to generate a significant amount of comments and appraisals from interested parties.

These comments have generally fallen into two categories: One, essentially universal agreement that, in the large scope, the need for modernization is not controversial, and the orientation and direction of the plan is fundamentally sound; and two, there are some individual items in the plan, such as specific products, which particular groups would like to see adjusted or modified, and these have been somewhat numerous.

These comments show me two things: First, that we have widespread support from within the user community and from outside consultants, that in principal, the National Airspace System Plan is appropriate and well-founded. Equally important, the second category of comments confirms that we have an active dialog under way within the aviation community. It insures that the plan addresses the needs of the various user groups. We receive their comments and respond to them. I have often said that the system belongs to the users. It is not FAA's system to be designed for our convenience.

Of course, our primary concern is safety, and we will not do anything to compromise this. I in no way mean to imply that anyone has suggested this. Beyond that, however, we are both willing and

actually seek to work with the various segments of the aviation community to help insure that the system meets their needs. We can't always give every individual or segment what they would like, because we naturally must take a broader view which encompasses the needs and wants of all, but we are genuinely willing to try to understand their concerns and seek every possible means to accommodate them.

It is evident that some of the comments we have received have been based on misinterpretation of the plan. For instance, some people believe that the plan would force general aviation pilots to install new equipment in their planes. This is simply not true. The plan does not contemplate the mandatory installation of any avionics. Rather, it would enable the individual pilot to choose the level of air traffic control services he or she wants to participate in—and the aircraft could then be outfitted with the appropriate level of equipment to receive those services. Clearly, however, the individual pilot or owner makes the choice.

I should mention that the plan does contemplate several enhancements that will benefit general aviation pilots. For instance, automated weather systems. As you know, Madam Chairman, adverse weather is one of the leading causes of accidents for GA aircraft. The goal of the expanded and automated weather system is to provide up-to-date weather information to pilots, flight service specialists, and controllers. Initially, the new system will provide weather and aeronautical data on the flight service station specialist's display. Later on, a second display will be added for weather radar, charts, and other graphics. Subsequently, the new system will be able to give pilots direct access to flight and weather services through remote computer terminals at airports, by telephone, or by direct data link from the airplane to the ground, again, the latter being the individual pilot or owner's choice.

In addition to increased pilot access, the new weather system will improve information gathering. For example, the plan calls for installation of automated weather sensors at airports to broadcast surface conditions by means of a computer-generated voice over VOR radio navigation stations to pilots, thereby increasing safety. This is another proposal which has been subject to misinterpretation. Some have interpreted this to mean that we intended to do away with all human observers and depend solely on the instruments. In fact, we have not even contemplated such a step, as there are some locations that, due to geography, require human observation and judgment, and will in the future.

A new Doppler weather radar system called Nexrad—for "next generation of radar"—will be developed to provide real-time weather data for air traffic control functions in en route airspace and in some terminal airspace. A new central weather service unit will be developed to disseminate real-time information on hazardous weather to pilots, air traffic controllers, and flight service specialists. By improving the collection and dissemination of weather data, we will improve the capability of the system to alert pilots to hazardous weather conditions, and thereby diminish the chance of weather-related accidents.

I would now like to turn to a topic which has generated a great deal of interest among those who have reviewed the plan, namely

the level of technology which the FAA proposes to use in the replacement system. Theoretical purists might say that we are not riding high enough on the technology curve, that there are other systems which could take advantage of more advanced technology. They are correct, as theorists. It is true that we do not intend to use the highest possible level of technology. The reason is quite simple: We are not operating in a laboratory or in a developmental environment. Our ATC systems control live traffic with people on board aircraft who rely on us to maintain proper separation of those aircraft 24 hours a day, 365 days a year, without interruption. We cannot afford the luxury of a system which would utilize the absolute latest in technology but might not be totally reliable.

To illustrate this point, when a computer company markets a new system, it does not say that the system will not fail. In fact, that company will not guarantee a reliability specification. Rather, it guarantees, for example, that the down time for the computer will not exceed 30 minutes per month. Madam Chairman, that simply is not good enough for a replacement ATC computer system. I seek computer capability to no more than 2 minutes of down time each year. Therefore, we had to back off from the peak of the technology curve in favor of greater reliability.

Another factor is that the NAS plan does not deal with a single system or even subsystem, but rather a collection of subsystems which must fit together and work immediately upon implementation. This is true of the sector suites and software as well as the hardware. If you were to look at any particular subsystem alone, you might find that it could benefit from higher technology, but this might not be compatible with other subsystems with which it must interact. Therefore, we slip a bit further down the technology curve once more. However, we feel that we will take advantage of the most advanced technology appropriate, given the special needs of the ATC system.

Another issue which has been raised, by the Office of Technology Assessment—OTA—in particular, is the accuracy of the FAA's forecasts of aviation activity. As I noted in my appearance before you last month, projected aviation activity increase is not the sole reason behind the need to modernize the national airspace system. The present system is rapidly becoming obsolete and is reaching its capacity limits. Furthermore, implementation of the National Airspace System Plan would provide safety enhancements, fuel efficiency, increased reliability, and cost savings which are desirable even if currently forecasted growth in aviation activity does not materialize.

I would still like to comment briefly on what I interpret to be the OTA concern. While OTA's general statements regarding the FAA's forecasts for the period from 1960 to the present are generally correct, I have pointed out to them that it is more appropriate to focus on the period from 1974 on, since that is when we adopted new econometric forecasting techniques. If you focus on this time period, you will note that our forecasts of the key variables, such as IFR aircraft handled at FAA centers and instrument operations at FAA towers, have been directly on target or slightly below actual activity levels which later occurred. These two variables are important for estimates used to determine FAA workload and are used

as inputs for overall planning and system design. These are the two factors that drive the system as regards instrument decisions on the ability to direct traffic.

I would like to address another subject, program management. Over the past months, as I reviewed the FAA programs, I also evaluated the process and procedures that were used to manage programs. Major changes in how the FAA will manage major acquisition programs are identified, and I have taken steps to implement those changes. Several months ago I published a plan for implementing new procedures for system acquisition management.

Major highlights of this plan include: One, identify major system acquisitions and focus top management attention on those key programs. I, as Administrator, will approve the initiation of any major program based on validated requirements.

Two, refocus and reconstitute the FAA Aviation System Acquisition Review Committee, or ASARC. I will chair this committee and the Associate Administrators will be active members. Attention will be focused on a review of these programs at critical decision points. Newly designated programs may enter the key decision process at different points depending upon their state of development when they are designated.

Three, establish an independent audit function under a separate Associate Administrator to evaluate program performance, schedule, and cost, and identify problems to the program manager, the ASARC, and myself.

Four, appoint a program manager for each major system acquisition. The program managers are to be provided appropriate authority, resources, and guidelines and held responsible for program accomplishment. Program managers will report to an Associate Administrator and will provide program reviews directly to me and the ASARC on a regular basis. I will retain sole approval authority for schedule changes and funding revisions.

Five, implement new procedures for program managers to "contract" work with FAA line organizations. This will enable program managers to utilize across-the-board FAA expertise on major programs. This contract will specify the work to be accomplished, the schedule for accomplishment, and the resources allocated for the work. The line organizations will be held accountable for performance on these contracts. Such a matrix method has been used by industry for over 20 years.

The changes in program management that I have outlined are now being implemented throughout the FAA. The advanced automation program is one example of a major program that will benefit from the improved program management process I have described. As you know, I have established a special project office within the FAA dedicated to carrying out this major program. An experienced program manager, Mr. Val Hunt, has been recruited from private industry, and is now serving as the Director of the new Advanced Automation Program Office. He will report directly to me, and I will hold him personally accountable for the accomplishment of the program.

Several activities of the new office are already under way. Both Mr. Hunt and I have met with representatives of the General Services Administration on numerous occasions to discuss obtaining a

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delegation of procurement authority for the new computer systems required for the advanced automation program. Several meetings have taken place to date, and discussions are still ongoing. I am confident that we will receive a delegation of procurement authority in the near future. GSA's advice has been very helpful. They are a tremendous repository of strong technical talent in the field of computers. And I am planning to establish a full-time GSA liaison officer on the staff of the Advanced Automation Program Office.

In addition to working with GSA, Mr. Hunt is preparing a program master plan for the advanced automation program, which I will personally review and approve. The plan will include a description of activities necessary for program accomplishment, a program work breakdown structure, a detailed program network, and refined cost estimates. He is also implementing a sound program management support system, including progress tracking systems, life-cycle costing systems, and earned value tracking systems. Other efforts, such as transition planning, specification preparation, and the implementation of a streamlined acquisition process are also ongoing.

A related point I would like to make is on the subject of the individuals who make up organizations, whether managerial staff or technical staff. In the end, all organizations and all programs are dependent upon the availability of well-trained, dedicated staff members to carry out agency missions. To assure the continued availability of well-qualified managers and technical staff for FAA positions, I started in April 1981 to explore various options within the academic community. I have asked the Nation's colleges and universities to help train future managers and engineers for the FAA and other aviation organizations.

I have asked for the establishment of a curriculum that would provide a basic foundation in the general elements of aviation and lead to bachelor degrees in airway science, and also offer the possibility of a master's degree. I believe that expanded participation by colleges and universities will enable both the aviation industry and the FAA to broaden the base for recruitment and result in enhancing the development of our work forces. This effort will lead to a significant increase in the trained cadre of future FAA employees, offer a wider base of capability for future management, and start a fundamental improvement in labor-management relations. I already have acceptance of the concept by three of our Nation's universities. We are in discussion with 24 more. One will have syllabus, staff, facilities, and faculty available for student entry this fall.

In addition, I have begun to initiate internal management controls throughout FAA. Part of this will be a realinement of all FAA engineering functions. My goals are to increase accountability and enhance productivity, thereby improving operational output. I have also undertaken a major effort in management-employee relations, which is intended to improve the supervisory and managerial capabilities of FAA, and make the agency a more pleasant and therefore more productive place to work.

Regarding the actual procurement of the systems and subsystems contained in the NAS plan, I have been working very closely with the Secretary of Transportation to streamline the acquisition proc-

ess. As you know, the Secretary and I both came from private industry, and we were most disappointed in the unreasonably long leadtimes necessary to process a major system acquisition within the Department. He has been a forceful element in removing unnecessary delays.

Our modifications of these procedures, which will be finalized shortly, will substantially reduce this processing time, thus greatly increasing our ability to deliver projects and products on schedule. I must say that I am gratified, but certainly in no way surprised, that the Secretary has taken such a strong personal interest in improving the major systems acquisition procedures. I believe this underscores his commitment to expedite the modernization of our Nation's airports and airways, with a significant reduction in cost to the American taxpayer.

In closing, Madam Chairman, I would like to reiterate that there is widespread support for the NAS plan, the entire principles contained therein. As I said last month, the difficult question is who should pay for it. At that time there was no agreement on this issue. I am pleased to note that since then, the vast majority of aviation user groups have indicated their support for the compromise proposal you have put forth. I believe this is a tribute to the subcommittee's commitment to the future of aviation and your skills in putting together a package that responds to the needs of all users.

Like the NAS plan, your proposal may not be the ideal plan for any segment of the user community, but also like the NAS plan, I believe almost everyone recognizes it is a fine compromise which balances many, often competing, interests. Most important of all, it responds to the true needs of both the current and the next generation of the traveling public.

Now that we have developed a blueprint for the modernization of the airways, and you have come up with a plan for funding it which enjoys widespread support, I urge that we get on with it and enact multiyear legislation which is needed to enable us to accomplish this modernization program.

That concludes my prepared statement, Madam Chairman. I welcome the opportunity to respond to subcommittee questions.

Senator KASSEBAUM. Thank you, Mr. Helms.

It is a pleasure not only to have sound back, but to have Senator Exon with us. You did not miss a lot, because no one heard what I said when I started out.

Senator EXON. I am sorry I missed it, Madam Chairman.

Senator KASSEBAUM. We have changed the procedure just a bit, and would like you, Mr. Helms, to wait until Mr. Jenney's testimony for OTA, and then have both of you respond to questions.

Mr. HELMS. Very well, Madam Chairman.

Senator KASSEBAUM. It is a pleasure to welcome Larry Jenney, Project Director of the National Airspace System Plan Review, Office of Technology Assessment.

STATEMENT OF LARRY JENNEY, PROJECT DIRECTOR, NATIONAL AIRSPACE SYSTEM PLAN REVIEW, OFFICE OF TECHNOLOGY ASSESSMENT, ACCOMPANIED BY ZALMAN SHAVELL

Mr. JENNEY. Madam Chairman, members of the committee, thank you for inviting the Office of Technology Assessment to appear before you today. With your permission, I will give a summary of our statement and ask that the full text of our prepared statement be inserted in the record.

Senator KASSEBAUM. Thank you.

Mr. JENNEY. Accompanying me today is Dr. Zalman Shavell, a member of the OTA staff, who is expert in computer and communications technology and who served as a member of the OTA project team.

Dr. Gibbons, the Director of the OTA, had the privilege to appear before you at hearings on May 24, 1982, when he presented to you the major findings of the OTA review of the FAA National Airspace System Plan. This review was based upon our assessment of the airport-air traffic control system—an 18-month effort undertaken at the request of the House Committee on Appropriations and completed at about the same time the NAS plan was released by FAA.

As a followup to this assessment, the House Appropriations Committee asked OTA to examine the NAS plan specifically. Our report, a copy of which has been furnished to this committee, represents the results of an intensive OTA staff effort supplemented by consultation with some 60 persons, principally at two workshops and at a general conference which was chaired by Dr. John McLucas, former FAA Administrator, and attended by representatives of several aviation organizations and experts in computer and communication technology.

My purpose today is to focus attention on those aspects of the NAS plan that are especially critical during the first steps of air traffic control system modernization, roughly the 5-year period covered by the FAA budget proposal now being considered by this committee.

In our written testimony, Madam Chairman, we address four issues that we believe are pertinent to this committee's interests today. They are: (1) the adequacy of the NAS plan as a planning document, (2) FAA's management capability, (3) the mode S data link and transponders, and (4) replacement of the en route computer system. In the interest of brevity, let me concentrate on en route computer replacement, which may be the most critical matter to be dealt with in the coming 5 years, at least from the technical point of view.

At the outset, let me advise the committee that, since our written testimony was submitted to you, OTA received a letter from IBM, the manufacturer of the 9020 computers now used in the en route traffic control system. This letter raises questions about FAA's analysis of options for replacing the system. Specifically, IBM indicates that upgrading 9020A to 9020D computers may not be as straightforward a procedure as FAA suggests. We have not yet had time to assess the implications of this letter, but as I pro-

ceed with my testimony, I will indicate where it may have a bearing on our findings.

FAA has chosen to replace the present en route ATC system in a four-step process. The first step involves transferring the existing software to a new central processor that emulates the present IBM 9020 but has greater capacity. This is called rehosting. The second step involves replacing present display units used by controllers with so-called sector suites compatible with the existing software and that have sufficient processing capacity to assume some ATC computer functions. Third, and concurrent with the second step, FAA plans to replace the present software with new software compatible with the rehost computer and capable of taking advantage of the new sector suite capabilities. And finally, the fourth step is to add new functions designed to enhance the overall performance of the ATC system.

In general, OTA finds that this is a reasonable approach. However, we have some questions about FAA's reasons for selecting this approach over others they considered.

FAA has stated that a major advantage of this approach is that it minimizes the risk during the period of transition to a new system by limiting the number of elements in the system undergoing change at any one time. And it certainly is true that making changes incrementally is less risky than making them all at once in a more dramatic way. Unfortunately, incremental change introduces the possibility of an entirely different kind of risk, the risk that choices made in the first stages might limit the options available for the final system design. In short, the future architecture of the air traffic control computer system may be constrained by the obsolete architecture of the system it replaces.

As an analogy, FAA's approach might be likened to buying a suit of clothing one piece at a time. First you buy a jacket to replace a worn out one and retain the pants. Later, you buy pants to go with the new jacket, and finally you buy a vest to set the whole thing off. It may well be that you end up with a satisfactory product, but it may not be as well matched and integrated as if you had bought the whole suit at one time.

Several experts with whom OTA has consulted have suggested that the goal of system modernization might be better served if FAA kept the present system running to meet demand through the early 1990's, while at the same time proceeding with a parallel effort to design and deploy an entirely new system to meet longer term needs. Advocates of this so-called clean-sheet approach agree emphatically with FAA that the present system must be replaced and that the first steps in this process should be undertaken as soon as possible. We certainly concur in that view. However, they advocate decoupling short-term remedial efforts from long-term replacement by finding a cost-effective way to shore up the present system with the intent of replacing it altogether by the late 1980's or early 1990's.

The chief advantage of this clean-sheet approach is that it would allow new system hardware and software to be designed in an integrated fashion, without either being constrained by the need for compatibility with the computer system now in place. The advantage of the clean-sheet approach is that it allows a bit more time

before selecting a replacement computer. In view of the rapidly changing state of computer technology, even 3 or 4 years could make a significant difference, with the result that the ultimate system of the 1990's could have more advanced hardware than it would have with a rehost computer selected now.

Thus, an alternative to FAA's proposed first step of buying a new host computer for the entire en route system now is to increase the capacity only at those centers that are expected to experience traffic overloads by the end of this decade. Of the present 20 en route centers, the 10 equipped with 9020D computer systems will have adequate capacity to meet projected demand until the middle 1990's, somewhat beyond the FAA's target date for system replacement. The other 10, which are equipped with 9020A computers, do not. Adequate capacity could be obtained at these centers by converting 9020A's to the more powerful 9020D's. OTA believes that this option, originally proposed by FAA but not adopted in the NAS plan, may have been discarded prematurely.

Let me expand on that point. In January 1982, FAA submitted to the Congress an analysis of technological options for replacing the en route computer system. I refer to the report entitled "Response to Congressional Recommendations Regarding the FAA's En Route Air Traffic Control System," FAA Document AAP-82-3, January 1982.

One of the options examined was that I just described, converting 9020A's to 9020D's at 10 sites as a near-term measure to assure adequate capacity while a replacement system is being designed and deployed. FAA's analysis showed that this option would give all 20 en route centers sufficient capacity to accommodate anticipated growth until 1996 or thereabouts, well after any new system could be deployed. FAA estimated that converting 10 installations from 9020A's to 9020D's could be completed by 1984 at a cost of $64 million. Installing a new host computer at all 20 en route centers as proposed in the NAS plan could be completed by 1986, 2 years later, and at a cost of about $250 million, or four times as much. On several other points of comparison, such as technological risk, constraint on future system design, and impact on FAA's management resources, the FAA's January option analysis showed that A-to-D upgrading was superior to rehosting. A summary of the FAA's analysis is presented in a table in our written testimony, Madam Chairman.

The same FAA report states on page 48, "FAA has already upgraded the 9020A at Jacksonville to a 9020D, so the transition process is well understood, and the cost, technical, and schedule risks are low. This does not, however, mean the transition is easy or nondisruptive."

IBM's letter to OTA indicates that A-to-D upgrading, though feasible, may be somewhat more difficult to accomplish than this quotation implies. Although about three-fourth of the components of a 9020A are common with a 360/65 model computer, others that are unique to the 9020D would have to be fabricated specially. This does not invalidate the upgrading approach, but it does suggest that FAA may have underestimated the practical problems that might be encountered if this route were chosen.

If, however, with the reservation that I have just mentioned, FAA's option analysis is accepted, A-to-D upgrade appears to be the approach that should have been selected. It offers quick relief from capacity problems at precisely the centers which now have or will soon have capacity problems, and with lower technical risk and at a lower cost. It also preserves the opportunity to undertake the overall design of a new system, unencumbered by possible shortcomings of a rehost computer selected, in part, for its capability to run the existing obsolete software.

I would like to emphasize, Madam Chairman, that OTA agrees that efforts for eventual replacement of the present system need to be pursued as vigorously and rapidly as possible. However, our view is that FAA has not presented convincing evidence that the selected approach, rehosting, is in fact superior to other alternatives. This is not to argue that rehosting is unworkable or ill advised. Rather, the point is that the FAA has not made a persuasive case for rehosting, and that the FAA should present such a detailed and direct comparison of the rehosting option, the A-to-D upgrading option favored in the January document, and any other options it wishes to present to the Congress.

This justification, it seems to us, is indispensable to an informed congressional review of the proposed computer replacement strategy. Such a head-to-head comparison of alternatives need not delay the overall schedule of system modernization. It could be accomplished rather quickly and could even advance the objectives of the NAS plan by providing the basis for a clear understanding at the outset on where FAA is headed and how it proposes to get there.

I might also mention that the General Accounting Office, at the request of the House Committee on Government Operations, has also reviewed the NAS plan and published a report in April 1982. GAO's findings parallel OTA's very closely on several points. GAO found that the NAS plan lacks the detail and the justification usually needed for budgetary approval and implementation. They also found that FAA's proposed en route computer replacement strategy poses both short-term and long-term risks. They advise that FAA consider less risky alternatives, among them conversion of 9020A's to 9020D's.

As a postscript, I would like to add that OTA's effort is but one part of the process by which the NAS plan is being scrutinized by Congress and the aviation community, the process Mr. Helms has just described to you. While some of the comments I have offered today have been critical of the NAS plan, they should not be construed as intending to take credit away from Mr. Helms and FAA for what they have set out to do. Mr. Helms' efforts to bring order to an enormously complex enterprise is commendable and speaks for itself. The observations I have offered today are intended to point out areas where the NAS plan could be improved or where additional clarification and justification are needed. OTA has endeavored to approach this matter constructively, and we welcome any response by the FAA or this committee.

That concludes my statement, Madam Chairman.

[The statement follows:]

STATEMENT BY LARRY L. JENNEY, PROJECT DIRECTOR, OFFICE OF TECHNOLOGY ASSESSMENT

Madam Chairman and Members of the Committee, thank you for inviting the Office of Technology Assessment to appear before you today. With your permission, I will give a summary of our statement and ask that the full text of our prepared testimony be inserted in the record of this hearing.

I am Larry Jenney, the Project Director for the review of the FAA National Airspace System Plan recently completed by OTA.

Accompanying me today is Dr. Zalman Shavell, a member of the OTA staff who is expert in computer and communication technology and who served as a member of the OTA project team.

Dr. John H. Gibbons, the Director of OTA, had the privilege to appear before you at hearings on FAA plans and programs held on May 24, 1982, when he presented to you the major findings of the OTA review of the FAA National Airspace System (NAS) Plan. Copies of the full report were also made available to the Subcommittee at that time. My purpose today is to focus attention on those aspects of the NAS Plan that are especially critical during the first steps of air traffic control system modernization that will occur over the next five years, the period covered by the FAA budget proposal that is now being considered by this Committee.

Let me emphasize at the outset that the NAS Plan is a comprehensive, long-term planning document covering a very broad range of ATC system improvements that will take nearly 20 years to complete. The activities proposed by FAA between now and 1987 thus need to be viewed as integral parts of a much longer process and need to be judged not only for their adequacy and soundness in and of themselves but also for their ultimate contribution to the long-range modernization program and to the goals of safety, capacity, and productivity. It is necessary to look very critically at these first steps because they will have an important influence on the final system design and the performance characteristics of the ATC system that will be in place at the beginning of the next century.

Viewed at a high level—as a statement of policies, goals, and directions—the NAS Plan is to be commended as a significant, and even bold, step compared to past FAA efforts to chart the future evolution of the National Airspace System. The proposed technological changes appear feasible and consistent with the goals of increasing safety and productivity and accommodating future growth. But the NAS plan is not without faults, and there are some areas that need further clarification or justification.

ADEQUACY AS A PLANNING DOCUMENT

OTA's first major concern about the NAS Plan, both overall and for the period 1982–87, is that, as a blueprint for the modernization of the ATC system, it does not provide a clear sense of the priorities or dependencies among various program elements. The Plan states the goals of the development process, but it does not relate these goals to specific programs in a systematic fashion, and nowhere in the Plan are program priorities delineated. If, because of budgetary constraints or failure to meet engineering objectives, it becomes necessary to eliminate certain items or to alter the schedule, the Plan does not make clear what effects this would have on the development of the system as a whole or how it could be done without compromising major objectives.

In view of the difficulties of keeping the parts of a complex development program on schedule, it is surprising that the NAS Plan does not deal explicitly with contingencies or the effects of schedule slippage. No endeavor of this scope and complexity can reasonably be expected to adhere to a nominal schedule. There are inevitable engineering problems; delays will occur even with the best of management; unforeseen circumstances will arise. One participant in the OTA working group on computer and communication technologies characterized the schedule as a "no-problems scenario," admirable for its conception but not realistic in view of the manifold implementation problems that might be encountered.

A related concern was expressed by many of the airspace users and technological experts with whom OTA consulted at workshops and a two-day general conference held as part of our review process. A widely shared view was that there are equally practical alternatives that might be as effective as those selected by FAA in meeting the goals of increasing safety and productivity and accommodating future growth. In some cases, it appears that these alternatives may have been rejected because they did not fit into the schedule dictated by FAA's projections of growth in demand for ATC services. In fact, providing capacity to accommodate anticipated overall growth in aviation appears to have been the principal factor in the choice of tech-

nologies and in setting the implementation schedule proposed in the NAS Plan. If FAA's long-term forecasts are too high, the pace of the schedule may be unnecessarily rapid, and some of these technological options may warrant reexamination. It would seem prudent, therefore, for FAA to adopt an implementation schedule that does not foreclose options prematurely and does not constrain the final system design.

A third shortcoming of the Plan as a planning document is that the development and deployment schedule seems to be driven by general, not specific, assumptions of long-term increases in traffic. The schedule is not tailored to specific components of aviation growth or to the needs for particular services at certain times and places. FAA's approach seems to be to implement the entire plan as expeditiously as possible to prevent the ATC system from being overwhelmed by growing demand. However, as FAA's own forecasts indicate, growth is expected to occur at different rates in different regions and among different user groups. The generalized response proposed in the Plan may not fit the pattern of growth and the particular requirements that will emerge over the next two decades.

For example, the Plan states that the major factor constraining the future growth of aviation will be the lack of capacity at major airports. Yet, the first part of the ATC system scheduled for modernization and increased capacity to handle traffic is the en route system. Terminal area ATC improvements, some of which could ease airport capacity constraints, are not planned for installation until the 1990's. Giving priority to improvements that would increase the throughput of en route centers does not seem entirely consistent with the forecasts of where the capacity of the system will be most severely limited. There is little apparent advantage in moving en route traffic more expeditiously only to have it encounter delays in terminal areas where capacity improvements will not be made until the early 1990's.

REPLACEMENT OF THE EN ROUTE COMPUTER SYSTEM

FAA has chosen to replace the present en route ATC system by an incremental process consisting of four steps: (1) "rehosting" the existing software in a new central processor that "emulates" the present IBM 9020 but has greater capacity; (2) replacing the present display units used by controllers with new "sector suites" comparable with the current software but containing sufficient processing capacity to assume some ATC functions; (3) concurrent with step 2, discarding the current software for new software capable of taking advantage of the new sector suites and (if possible) compatible with the "host" hardware; and (4) implementing a number of advanced functions designated to enhance the overall performance of the ATC system.

OTA's review indicates that, in general, this is a reasonable approach; but we have some questions about the reasons that FAA has stated for selecting this approach over others that were considered.

FAA has stated that a major advantage of this approach is that is minimizes risk during the period of transition to new system. Many of the participants in OTA's general conference agreed, but others pointed out that there is no risk-free way to replace an operating system with a new one. An incremental approach seek to control risk by limiting the number of elements of the system undergoing change at any one time. It may result in less overall risk than if the change were make all at once in a more dramatic way. Unfortunately incremental change introduces the possibility of an entirely different kind of risk—the risk that choices made in the first stages might limit the options available for the final system design. The future architecture of the ATRC computer system, in short, may be constrained by the obsolete architecture of the system it replaces.

Several experts have suggested that the goal of system modernization might be better served if FAA kept the present system running to meet demand through the early 1990's, while at the same time proceeding with a parallel effort to design and deploy an entirely new system to meet longer-term needs. Advocates of this "clean-sheet" approach agree emphatically with other experts that the present system must be replaced, and that the first steps in this process should be undertaken as soon as possible. However, they also point out that any equipment acquired in the short term—including perhaps FAA's "rehost" computers—would probably have to be modified, replaced, or augmented with other computers when the new system is deployed in the 1990's. Thus, they advocate decoupling short-term remedial measures from long-term replacement by finding a cost-effective way to shore up the present system with the intent of replacing it altogether when the new system comes on line. The chief advantage of the "clean-sheet" approach is that it would allow new system hardware and software to be designed in an integrated fashion,

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without either being constrained by the need for compatibility with the computer system now in place. Another advantage of the "clean sheet" approach is that it allows a bit more time before selecting a replacement computer. In view of the rapidly changing state of computer technology, even three or four years could make a significant difference, with the result that the ultimate system of the 1990's could have more advanced hardware than it would with a rehost computer selected now.

Thus, an alternative to FAA's proposed first step of buying new "host" computers for the entire en route system now is to increase capacity only at those centers that are expected to experience traffic overloads by the end of this decade. Of the present 20 en route centers, the 10 that are equipped with 9020D computer systems will have adequate capacity to meet projected demand until the middle 1990's. The other 10, which are equipped with 9020A computers, do not. Adequate capacity could be obtained at these centers by converting the 9020A's to the more powerful 9020D's. OTA believes that this option, originally proposed by FAA but not adopted in the NAS plan, may have been prematurely discarded.

Let me expand on this point. In January 1982 FAA submitted to the Congress an analysis of technological options for replacing the en route computer system.[1] One of the options examined was converting 9020A's to 9020D's at 10 sites as a near-term measure to assure adequate capacity while a replacement system was being designed and deployed. FAA's analysis showed that this option would give all 20 en route centers sufficient capacity to accommodate anticipated growth until 1996, well after any new system would be deployed. FAA has demonstrated the feasibility of this approach in the conversion from a 9020A to a 9020D system at the Jacksonville center, and the option analysis report indicates that such a conversion could be effected at other centers. FAA estimated that converting 10 installations from As to Ds could be completed by 1984 at a cost of $64 million; installing a new host computer at all 20 en route centers (as outlined in the NAS Plan) could be completed by 1986 at a cost of about $250 million. On several other points of comparision—such as technological risk, constraint on future system design, and impact on FAA's management resources—the FAA's January option analysis showed A-to-D conversion to be superior to rehosting (see the accompanying table).

COMPARISON OF REHOSTING AND UPGRADING 9020A's TO 9020D's

	Rehosting	A-to-D upgrade
Description	Rehost present software on new computer, then replace software and add additional processors needed for advanced system.	Upgrade 9020A computers to 90200 at 10 centers, then replace hardware and software in a single step, and finally upgrade computer to advanced system.
FAA evaluation:		
Schedule	Computer replacement 1986. Software replacement 1990. Full advanced system 1992.	Computer upgrade 1984. New computer and software 1989. Full advanced system 1993.
Cost of first step	$250,000,000	$64,000,000.
Total cost	$1,390,000,000	$1,390,000,000.
Risk	Rehost may constrain future system	Low.
Impact on FAA resources	High	Medium.
Ability to evolve	Medium	Unconstrained.
Transition impact	High	Medium.

Source: Federal Aviation Administration, Response to Congressional Recommendations Regarding the FAA's En Route Air Traffic Control Computer System, DOT/FAA/AAP–82–3, January 1982.

Some participants in OTA's technical working group and the general conference indicated that, based on FAA's analysis, the A-to-D upgrade option is the one that should have been selected. It offers quick relief from capacity problems at precisely the centers that now or will have problems, with lower technical risks, and at a lower cost. It also preserves the opportunity to undertake the overall design of a new system unencumbered by possible shortcomings of a rehost computer selected, in part, for its capability to run the existing obsolete software.

Statements made by FAA since the NAS Plan was released indicate that the choice of the rehost approach was based on four major considerations.

[1] Federal Aviation Administration, Response to Congressional Recommendations Regarding the FAA's En Route Air Traffic Control Computer System DOT/FAA/AAP–82–3, January 1982.

(1) Ability to meet capacity needs projected for the late 1980's: The FAA report to Congress in January 1982 asserted that A-to-D upgrade would also allow the projected demand for services to be met through the mid-1990's, or later if the demand materializes more slowly than expected.

(2) Improved reliability and maintainability: The reliability of the 9020 system appears to be more a problem of software than hardware, and since the present software would be retained, neither approach would alleviate this problem. Further, FAA has stated that, with or without rehosting, it plans to procure sufficient spare parts to keep the 9020s operating satisfactorily until the new computer system comes on line at the end of this decade.

(3) Ability to support productivity increases planned under AERA: The planned productivity increases to be realized from AERA will result mainly from software improvements not hardware changes; but, in any event, AERA will not be implemented until the early 1990's when the new computer system would be in place under either option.

(4) Reduced developmental risk: The incremental rehost approach reduces some kinds of developmental risk but—as argued above—it introduces another kind of risk, namely that hardware choices made in the first stages might limit the options available for the final system design.

OTA does not find these reasons, either individually or collectively, to be persuasive arguments in favor of rehosting.

In sum, OTA agrees that efforts for eventual replacement of the present system need to be pursued as vigorously and as rapidly as possible. However, FAA has not presented convincing evidence that the selected approach—rehosting—is in fact superior to other alternatives. This is not to argue that rehosting is unworkable or ill-advised. Rather, the point is that FAA has not made a persuasive case and that FAA should present a direct and detailed comparison of rehosting, A-to-D upgrading, and any other options the FAA considers workable. This justification is indispensable to an informed Congressional review of the proposed computer replacement strategy. Such a head-to-head comparison of alternatives need not delay the overall schedule of system modernization, and it could even advance the objectives of the NAS Plan by providing a basis for clear understanding at the outset on where FAA is headed and how it proposes to get there.

It should be noted that the General Accounting Office, at the request of the House Committee on Government Operations, has also reviewed the NAS Plan (Examination of the Federal Aviation Administration's Plan for the National Airspace System—Interim Report, AFMD-82-66, April 20, 1982). GAO's findings very closely parallel OTA's on several points. GAO found that the NAS Plan lacks the detail and justification usually needed for budgetary approval and implementation. They also found that FAA's proposed en route computer replacement strategy poses both short-term and long-term risks, and they advise that FAA consider less risky alternatives—among them conversion of 9020A's to 9020D's.

DATA LINK

Communication is the backbone of air traffic control. Instructions and information vital to the safety of flight must be communicated between ground and air and between ATC facilities on the ground. While the present requirement for air-to-air communication is minimal, this link may assume greater importance in the future.

In the NAS Plan, FAA indicates that a new data link (Mode S) will be the primary channel for transmitting data between the ground and the air and between aircraft in flight. Mode S will be necessary to support the automated ATC system that FAA proposes for the future and for the distribution of weather information and other data of interest to aircraft in flight. It may also be used to collect weather observations from appropriately instrumented aircraft as part of the real-time weather system envisioned by the FAA. Another important advantage of the Mode S data link is that it will improve the quality of surveillance data avialable to the ATC system. This data link will also be used in TCAS, the collision avoidance system adopted by FAA, to coordinate the maneuvers of aircraft when a possible conflict is detected.

Use of this data link will involve installation of Mode S transponders on aircraft wishing to operate under Instrument Flight Rules or in controlled airspace. By the end of the century, FAA expects that Mode S transponders will be needed for all instrument flights above 6,000 ft. (mean sea level). FAA expects that most aircraft operators will have equipped voluntarily by that time, because of the enhanced services that will be available only to aircraft carrying Mode S transponders.

The principal beneficiaries of the Mode S data link will be those who operate aircraft under IFR in en route and controlled terminal airspace on point-to-point flights—that is, commercial air carriers and business and corporate general aviation. For such users, FAA estimates that the improved services made possible by the advanced ATC system with an integral Model S data link will permit more fuel-efficient routings that could save up $250 million per year in fuel costs.

The benefits of the Mode S data link for the vast majority of the civil aviation fleet—private general aviation aircraft—are not as clearcut. With 214,000 aircraft, the GA fleet is about one hundred times larger than the commercial fleet (2,541). Most of the GA fleet is made up of single-engine aircraft, operated by private pilots who rarely fly under IFR. The Mode S data link is expected to provide improved weather information, but pilots of small aircraft operating under VFR would probably make little or no use of the other new ATC services.

Though the 1982 NAS Plan makes the decision to equip voluntary, the GA pilot who does not have a Mode S transponder will find the volume of the airspace available to him becoming smaller. As a result of altitude restrictions, many fliers who would prefer to fly VFR may be forced to equip their aircraft for IFR operation and to fly "on system" in order to avoid delays and unattractive routings or to gain access to more airports.

MANAGEMENT CAPABILITY AND PROCUREMENT STRATEGY

FAA has set itself a complex task of system development and deployment—more complex than any it has attempted before—and there is room for doubt about the prospects of keeping to the time line laid down in the Plan, especially since there are so many elements and paths of development that must be coordinated.

Replacement of the en route computer system, for example, involves two major procurements—the rehost computer, and then new software and sector suites. FAA's proposed strategy is a complicated process that involves selecting from all competitors two "finalists" for each of the two major procurements. These finalists will then be asked to demonstrate their proposed system at the Test Center in Atlantic City, after which a production contract will be awarded to one of each pair.

For just one of the many NAS Plan programs, therefore, FAA is placing itself in a position where it must manage four major contractor efforts at the same time. The work of these contractors, and possibly several subcontractors, must be coordinated and kept on schedule. Equally important, these contractors must be kept insulated from each other to preserve competition and protect proprietary information. A less complicated strategy might have better chances of success, given the management problems inherent in this approach.

If FAA concludes that its proposed approach of directing four contracts at one time is, in fact, the best way to proceed, then—as a minimum—the agency should take additional steps to increase its internal capability in the area of systems acquisition management. It should also engage the services of a system integration contractor and give that firm a strong hand in coordinating system development.

The GAO report on the NAS Plan, mentioned earlier, made particularly strong recommendations in this regard. GAO noted that FAA has not yet developed a detailed plan for making the transition from the present ATC system to the advanced system of the 1990's. It is essential that such a plan be developed to insure continuity of service and smooth, safe transition at each step along the way. GAO concludes—and OTA's analysis also indicates—that an indispensable adjunct to the transition plan is creation of managerial and administrative resources to implement the plan and to monitor the course of system development and installation. Strengthening its capability in this area is, we find, a matter to which FAA should properly give first priority.

I am happy to say that FAA recognizes this need and has recently announced internal management changes to improve these capabilities. It is still too early, however, to judge the effectiveness and adequacy of these steps.

CONCLUDING REMARKS

As a postscript, I would like to add that OTA's effort is but one part in the review of the NAS Plan by Congress and the aviation community. While some of the comments I have offered today have been critical of the NAS Plan, they should not be construed as intending to take credit away from Mr. Helms and the FAA for what they have set out to do. Mr. Helms' effort in bringing order to an enormously complex enterprise speaks for itself. The observations I have offered today are intended to point out areas where the Plan could be improved or where additional clarifica-

tion and justification are needed. OTA has endeavored to approach this matter constructively, and we welcome any response by FAA or this Committee.

Senator KASSEBAUM. Thank you very much, Mr. Jenney.

Mr. Helms, if you could please come back, some of the questions we would like to ask certainly can best be answered perhaps by both of you together, and it will help our understanding.

Mr. Helms, in your testimony, you discussed efforts to set up a management team within the FAA to carry out this program. Have you considered the use of a non-Government management team to maintain a continuity through administrations? This is one question which has come up often, as you well realize. You have lent such leadership to this plan. What groundwork are you setting up to carry on?

Mr. HELMS. Madam Chairman, we recognize the need both for continuity in management and also for additional technical expertise. Therefore, in the procurement plan which is being drafted, which I have discussed with the Secretary and is in its final form just about now, we identify the use of an outside private systems contractor who will work solely for the FAA. That contractor will have a hardware exclusion clause in the contract which clearly indicates he cannot participate in delivering hardware to any part of the system.

This is going to be a very large technical effort, and they will serve as a direct support to the FAA, and help us insure that the technical effort is being properly undertaken.

Second, we will have a second technical outside contractor whose sole purpose will be to insure that the final system contractor's efforts in software are validated and verified.

So, Madam Chairman, we will have two outside contractors working directly for the FAA who do the technical and system planning effort, to assure it is being done right, and to help us, so there will be continuity even if I am gone.

Senator KASSEBAUM. Thank you.

I understand that the decision on the altitude requirement for mode S will be made at completion of the national airspace review, which will be completed in, I believe, about 3 years. This is the organization you have set up at this time within FAA. Is that not right? Is this in-house?

Mr. HELMS. Partly right, Madam Chairman. First, the national airspace review is being conducted primarily, by the users. Literally over 98 percent of the people are from outside the FAA. I specifically wanted to balance out the internal effort, the National Airspace System Plan, with the use of that airspace by the users, so the national airspace review is being made up essentially solely by people outside of FAA.

As regards the application of their findings to the 6,000-foot altitude requirement, of course, we have established no requirement as yet. We have not done that, and there are two other elements that would significantly affect that, one being whether aviation activity does in fact grow the way the present projection shows. If it does not, then you start to impact whether you go forward with the mode S transponder requirement or not. If you do not have the additional population of aircraft, you do not need it. The present ATCRBS system will work. That was built into our plan to recog-

nize that as early as 1986 we may have to modify and start the mode S transponder, but in fact the present ATCRBS could be used indefinitely. Therefore, we could defer until 1990 or 1991 the final decision whether we had to mandate a change, and we do not have to make that decision until we know whether we have 300,000 airplanes in the air as opposed to 150,000 or 200,000. That will start to drive the decision on the 6,000-foot altitude requirement, so we do not have to make that decision now. We can wait many years before we must finalize that decision.

The one thing we cannot do is to put automation in later. If we decide that ultimately we will have to have automation, we cannot design a system and get it underway and say at a later date maybe we should automate. That decision has to be made now.

Senator KASSEBAUM. That leads to the crux of some of the differences of opinion between OTA and FAA at this point, and I would like to ask a question regarding the option that was put forward and then rejected by the FAA as an interim step to replace the 9020's from A to D. The FAA has estimated the cost on that conversion would have been $64 billion.

Mr. HELMS. Million.

Senator KASSEBAUM. As a member of the Budget Committee, I have lost track of millions and billions.

OTA has suggested that this approach coupled with a later upgrading of the hardware and software might be a better approach to create a new system. Within the last few days, a letter has come from IBM. I assume this is the letter you referred to, Mr. Jenney, which suggests that the 9020 is a unique computer and could not be readily converted from available 360's. IBM indicated to us the cost of such conversion, if it could be done, would be much more costly than the original estimate. Are you familiar with this information, Mr. Helms and Mr. Jenney? Is that the information you have?

Mr. JENNEY. The IBM letter to us did not include a cost estimate of the conversion. It suggested the process might be rather more involved and entail more remanufacturing and perhaps, therefore, might be more expensive; but cost was not specifically addressed in IBM's letter to us. We will, of course, make a copy of the letter available to this committee.

Senator KASSEBAUM. Should cost be a factor?

Mr. HELMS. I think, Madam Chairman, we need to back up and take another look at it. If I had to pick the one item that has been the greatest item of difficulty in discussing this, it is having people recognize the meaning of the word "system" at its highest level. When I use the word at the highest level, I am talking about the national air transportation system, not just the subsystem of hardware or the sub-subsystem of the computer and the automated program, the advanced automation program.

For example, if we take the 9020 A to D conversion, the OTA is correct, the one in Jacksonville was converted, but that was done years ago, when parts were in production and we had them identified. It was on the basis of that one conversion that the $64 million estimate was made, but there are other issues so far more important that that one really falls out into raindrops. Let me show you.

If you take that step, and say we could do it for $64 million, say we could do it for $50 million, then you are making the decision first to throw it away. You have bought yourself a little bit of time, but you have definitely made a throwaway decision. Even that is insignificant, as you will see. Second, when you make that step and go forward, what you have done is said, under no condition can I put in the advanced capabilities which will reduce cost. That is the driver right there.

The fact that you can convert it A to D is inconsequential. Why? Converting all of them from A's to D's and keeping the people employed between now and 1995, if we can stretch it to then, would be saying that the difference between $64 million and $250 million is more important than over $7 billion we would have to expend for people. If you go A to D you cannot put in the new sector suite. You cannot put in the new software which will allow us to increase efficiency. You cannot do the items which will save over 300 million gallons of fuel a year for the air carriers alone. That is $300 million.

It is not until you back off and take a look at the total system that you start to put these things in the proper perspective, and when you do that you realize the difference between $64 million and $250 million is lost, Madam Chairman. It would be literally wiped out in less than 15 months of employees' wages.

Senator KASSEBAUM. Mr. Jenney, is that a factor in your analysis, or are you just believing that this would be a better way to approach the interim step?

Mr. JENNEY. I would like to make two points, Madam Chairman. First, OTA is not arguing that A-to-D upgrading is, in fact, better. Our argument is, that we have before us two documents from the FAA. We have the January options analysis report I cited in my testimony, which very clearly favors A-to-D upgrading followed by an integrated total system design of a replacement. By the criteria used in that analysis, that option appears to be superior. However, we also have the NAS plan issued in the same month by the FAA which reaches a different conclusion. Our basic point is that we believe it would be instructive for the Congress and perhaps would advance the entire matter more expeditiously if we had some direct and explicit comparison of those two options and some explanation of the rationale—such as Mr. Helms has just suggested—for the choice of the rehost approach.

My second point concerns the availability of the new system. A point that is, I think, overlooked with respect to A-to-D upgrading followed by system replacement is that the process could be completed at virtually the same time as the rehosting approach proposed by FAA. That is to say, the new system—the whole integrated package of hardware, software, sector suites, and the new automation concepts that are implicit or possible thereby—could be put on line at about the same time as FAA's proposed system, by the late 1980's or the early 1990's. So the overall schedule is the same. It is the relationship of the steps within the conversion process that differ. Therefore, the benefits to be realized by one accrue at about the same time as the benefits to be realized by the other.

Mr. HELMS. Madam Chairman, during the evaluation of this, we looked at 13 different configurations. The questions that I asked of

our group, our technical group resulted in reports that will stand literally, from the floor to my waist. There are that many pages. Part of the things OTA brought up are absolutely valid. They are the same questions I raised during that time period. But, for example, one of the major items which OTA raised was our ability to manage it. If we have difficulty managing one new system, we will have far more difficulty managing two, which is the consideration of a large program to convert A's to D's, bring those on line, install those at the same time we are trying to build a management team to take on the new host system. It was a major factor when I looked at it; the FAA does not have that capability and we cannot contract that out to that extent. We would then have four contractors.

Oddly enough, I am told the Presidential Scientific Advisory Committee now studying this is encouraging us to go more rapidly rather than delay. There is one other aspect. Once we consider that you are not taking advantage of technology, then you have to take a look at it and say why, and that is absolutely correct. We are not riding the technology curve, for the simple reason, first, I would rather have reliablity, and second, we must make all of these items go together.

The analogy was used of a man buying a coat and then not having a pair of pants. I would take that analogy and say, as a return on investment, that would be the wisest thing he could do as long as he can get the same material, because as each coat wears out, he can match it with pants and still be in style. So, to me, that is a perfect thing to do. As a matter of fact, I personally own six blue blazers because I like them.

So, I find as a return on investment of funds, it is a practical thing. I do not take exception to their suggestion to look at it, but I would say we have taken a look at it. I would strongly urge them to come over and take a look at them in detail. For example, the comment was made on the GAO's finding this year that also agreed with them. Now, more properly, I should advise the committee I have written a letter to Chairman Brooks which notes for him that the GAO report of last year was exactly opposite, and in fact its strong recommendation was that the FAA go host.

As I pointed out to them, we can no longer delay this. The delay has gone on for years and years. We paralleled the findings of last year, and now it is recommended we change. So, it depends upon which GAO report you pick.

Senator KASSEBAUM. You can see why frequently it is hard for people to understand which is the best approach.

Mr. HELMS. Yes, ma'am, I can.

Senator KASSEBAUM. I think the question of the state of the art technology is interesting and is perhaps at the heart of the decision, the overall assumptions on this. I guess that I would point to the fact that the Department of Defense has really gotten very bogged down in some weapons systems in an attempt to meet the state of the art technology, and have as a result developed some serious problems.

Mr. HELMS. In deference to OTA's comments, Madam Chairman, I not only agree that when you take a system and do not take the advanced technology, and you do this in sequence, I believe the

phrase was used that you compromise, or you start to compromise the future capability. I agree with that 100 percent. I say you not only might, you definitely will compromise the total future output, and that is a decision I made to assure that we would have reliability and be able to stay on schedule.

One of the items was, can you manage it. You can manage something simple and reliable easier than others. But the observation by OTA is correct; the approach we have taken will result in a less capable system, but it is quite adequate, and one with my confidence, and that is the reason I would like to go this way.

Senator KASSEBAUM. You have stated you felt the risks to the public were not as great.

Mr. HELMS. Yes, ma'am.

Senator KASSEBAUM. I think that is important.

Mr. HELMS. Yes. A parallel we have used in internal discussions is, when this Nation made a 10-year commitment to put a man on the Moon for Apollo, we could have slipped that launch 1 year, 6 months, or 1 week, whatever we had to. When we cut our air traffic control computers over at midnight, at 12:01 it has got to work. It is not a case of whether it can. It has to work. And I cannot take the risk of advanced technology. I must have systems I know will work, and having in my hip pocket the possibility of converting A to D as a fallback position, in case something happened I did not anticipate, was a conscious decision on my part. If something went wrong, I wanted something in my hip pocket to allow us to continue.

But keep in mind, none of the advanced features we have described are possible with an A to D conversion. Even though we could make it last until 1994, we are then making the decision there will be no new sector suites, no automated en route, no fuel savings, and we will keep people employed to the tune of over $7 billion in just the area of direct working controllers only. We are talking in terms of saving $24 billion by the year 2000. Over half of that would start to be wiped out by the time we added all the other elements to it, Madam Chairman.

Senator KASSEBAUM. Do you agree with that analysis, Mr. Jenney?

Mr. JENNEY. I think we may have a semantic difference here. The savings that would be achievable under the approach Mr. Helms has described are certainly significant, and we do not disagree with his analysis. However, we do suggest that the other approach, namely, A-to-D upgrading followed by an intensive and expeditious design of the new system, would also achieve similar savings in FAA man power and fuel used by aircraft operators. It would certainly be as safe and as efficient a system. Further, the benefits would also accrue at about the same time and be of same magnitude. We have not costed out the option of the A-to-D upgrading so I am giving only a horseback estimate.

Senator KASSEBAUM. Would you agree if you do the A–D conversion, that you cannot get to the rest of the system, the rehosting?

Mr. JENNEY. If you go the route of A-to-D conversion, you cannot go much further than you are today, although you can add some of the automated functions that are proposed for the system eventually.

Mr. HELMS. A 30-percent increase.

Mr. SHAVELL. Of the total of 11 automated functions that would be added, 7—according to FAA's response to the Congress—could be accommodated by an A-to-D conversion. The remaining four, which are the ones Mr. Helms is talking about—fuel-efficient route planning, flow planning, strategic clearance planning, and tactical clearance generation and delivery—would in either case have to wait until the 1990's. Since they could not be accommodated by A-to-D conversion.

Mr. HELMS. That is correct.

Mr. SHAVELL. The rehost offers that possibility.

Mr. HELMS. But the separation is, with A to D, you cannot bring on stream the sector suite, and that is where you decrease your labor costs. That is where the billions of dollars come out. There is not sufficient capacity in the 9020D to do the automation requirements for a sector suite.

Senator KASSEBAUM. Mr. Helms, how would the plan affect VFR flying as we know it today? What percentage of general aviation flying with single engine piston aircraft operate above 6,000 feet?

Mr. HELMS. The plan will have zero effect on VFR flying as it is today. To the extent that today's flying VFR requires a transponder to go into a high density area, that would be paralleled also, but it would have zero impact. In fact, I used the analogy which most people have forgotten. Federal aviation regulations allow a plane to fly today without lights, and in fact people buy them without lights, so you don't have to have the equipment. With regard to the 6,000-foot limitation, there will be no constraint at any time until such time as we see that the aviation population density, that is, the number of aircraft, developed to the point where that is the only way of separating them.

If our forecasts are wrong, fine. We will never have to do that. That is if it is lower. If it is higher, it validates the fact that the only way we can do that is to start automation right now, in which case we would have to have some change.

Senator KASSEBAUM. Do you know what percentage of planes fly above the 6,000-foot level?

Mr. HELMS. No, I do not. I will dig into it, Madam Chairman, and try to furnish it for the record.

Senator KASSEBAUM. I was curious.

Mr. HELMS. It would be my intuitive judgment only that probably 60 to 70 percent fly at 6,000 and below, but I could not say it from detailed research and knowledge.

Senator KASSEBAUM. Why does the FAA plan require the mode S for aircraft using certain airspace, but not mandate TCAS for the same airspace?

Mr. HELMS. Mode S would be a method of switching from the present ATCRBS type of transponders to the new type of transponders.

Senator KASSEBAUM. Yes, I have had to learn a whole new language.

Mr. HELMS. We had tried to come up with a method whereby the general aviation owner who has made an investment will have many years' usage. That says then that if we are going to change, we should advise the community far enough in advance that they

can make plans to change. In fact, the data format, the electronic signature of the new mode S and the old ATCRBS. They are both compatible, which says that if we go that way, those old ATCRB transponders can be used for years and years. It could let us go through the end of the decade, past 1990. So the reason I went that way instead of TCAS and the other ways was to make sure the present general aviation pilot or owner could use his equipment for at least another 8 or 10 years, and in fact if the population does not come up, he could go 15 years.

As regards TCAS, I feel that some pilot who flies from Abilene, Kans., to Tucumcari, N. Mex., if he is not in a high density area and does not want to, he should not be forced to equip. If he has a transponder that will allow him in a TCA he also can equip with a TCAS and have protection outside of radar coverage. So the system design is such that he would not have to buy any new equipment. He would get some protection, and he has the option of going the full route if he wishes. I would not want to make it mandatory. I feel that that is not a proper role at this point in time.

Senator KASSEBAUM. The ATA in its testimony suggests that since new host computers will be off the shelf, that the extended bid procedures and 1-year competition is really not necessary, that the procedure to procure the equipment as well as software development could be shortened by perhaps a year without really jeopardizing a safe transition. How would you respond to that, and how did you decide what procurement procedures were to be used?

Mr. HELMS. I think I am about 80 percent of the view that they are correct. We have a separate study under way now which indicates that precisely that situation does exist, that we could take out close to a year. If we did that, of course, now we come back to the basis of the competition, and under A-109, which is the method of procurement, you have to adopt a strategy of 5-3-1-1. It was in an effort to maintain a competition up to the point that we knew we had this reliable system. If we find, as a result of this independent study which is now under way and due to be completed shortly, that from this we could have sufficient competition we could go; I would not hesitate. It would save us time and money, and we would get on with it. I am just not prepared yet to say we can do it.

Senator KASSEBAUM. What criteria will be used to determine the final number and location of en route centers and approach control facilities and flight service stations? This, as you know, is of great concern to many, perhaps far and beyond just the technological reasons.

Mr. HELMS. Yes, ma'am. The national airspace system plan is not dependent upon nor is it in any way directly related to what might be done in the way of closing or consolidating facilities. Backing off from the thrust of the chairman's question, the current basic air traffic control system was laid out in the late fifties and early sixties, and it was responsive to the technology then existing, particularly in the field of communications. Today, surface communications and satellite communications costs are so dramatically different that you can start to combine functions and save a tremendous amount of money.

For example, one center costs us about $32 million a year. If we closed five centers, we would have saved $150 million, and in 5

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years that is $750 million. I have no choice but to take a look and see how can I use technology in the proper role and match it in the right place. There is no connection directly with the national airspace system plan. In one area this has already been approved by the Congress and is under way, the consolidation of flight service stations, and I think this is a good example of how you can build in protection. In the case of the flight service station modernization program, we have contracts now for computers. The displays are on the way. But if we run into a problem, all we do is just not combine it so rapidly. We leave the existing flight service stations there. It would cost us more money, about $190 million a year, if we had to keep them there, but the point is, we have a backup we can use.

Senator KASSEBAUM. Are you taking any steps to assure that if there was an overload in the system there is backup for air traffic controllers?

Mr. HELMS. Are you speaking in the present short term, within the next year?

Senator KASSEBAUM. Yes.

Mr. HELMS. Yes, ma'am. That one, there is no question about it. The President, the Secretary, and myself agree, we will not allow more aircraft in the air than our controllers can safely and adequately handle. I certainly do not like the idea of slots or restricted air traffic, but everyone, after they get through giving me a hard time and accusing me of wearing the biggest, blackest hat in town, will inevitably agree that is a requirement for safety. I do not like it, but I will tolerate it. We are recovering well, as far as I am concerned. We are on our recovery schedule, and I am satisfied we will start to see benefits shortly. We are already under way now on relieving general aviation requirements and reservations in the Salt Lake City area and others.

Senator KASSEBAUM. If there should be a system failure along the way, though, not just as a result of the air traffic controller plight, but a system failure, is there a mechanism you would see under consideration to prevent an overload for an air traffic controller? This is what I meant, more than just a shortage of controllers.

Mr. HELMS. We do have a program, DARC enhancement. We have the DARC program, which is direct access radar channel, which allows us to go around the central computer, but the problem is the controller must put his display down and go back to shrimp boats, the little plastic things. We have under way now a program of DARC enhancements. We did it to bridge the gap between now and the time a host computer can be brought on stream. That will allow us to shift direct, and if the center computer goes down, the controller will know it. There is no question about it. He will not have the total capability, but at no time will he lose direct data, so we think that program will give him the backup necessary.

Incidentally, that would stay in effect probably up until the time period the OTA gentleman referenced, 1993 and that time period, because until we fully went to the new system and checked it out, we would keep the backup system in existence.

Senator KASSEBAUM. Mr. Jenney, do you know the FAA must seek appropriations every year to carry out its program even

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though, of course, we have authorized it for 5 years? I wonder if OTA plans to follow through with a study of the airspace systems plan and assist in the appropriations process, or do you regard your work as completed in the analysis initially?

Mr. JENNEY. As you are aware, Madam Chairman, OTA responds to the requests of the chairmen of congressional committees. If they request us to follow up on a study or to initiate a second or third study, we would do that, of course with the approval of the Technology Assessment Board, which governs these matters for OTA. We have received no such request from the Appropriations Committee. We have found in the past that, if an issue remains of interest to the Congress, we are called upon for supplementary submittals, additional analysis, or some followup action, but we have no specific intent to do so at the present time.

Mr. HELMS. In that connection, Madam Chairman, the Chairman of the House Appropriations Subcommittee, Mr. Benjamin, discussed this with me, and asked how I would feel about an annual review specifically on this program before a final judgment was made by his subcommittee, and I agreed without any reservation. I do not know with certainty, but I have a feeling based upon that that he intends to have an additional review.

Senator KASSEBAUM. I should think it would be very beneficial.

Mr. HELMS. We would welcome it.

Senator KASSEBAUM. Mr. Jenney, you mentioned there were 214,000 aircraft in the general aviation fleet versus 2,400 in the commercial, and that most of these small, single-engine aircraft are operated for recreation or small business purposes. Has OTA found any estimates of the extent to which these aircraft operate into and out of large commercial airports, and do you think the mode S or TCAS system should be required on aircraft operating into commercial airports?

Mr. JENNEY. I do not have at my disposal at the moment precise figures on how many of the fleet of 214,000 or so aircraft classed as general aviation aircraft operate into and out of major hub airports or into and out of controlled airspace. The number is likely to be rather small in terms of the percentage of the aircraft. However if you look at it in terms of hours of use of all aircraft divided between VFR and IFR, where GA aircraft do operate in controlled airspace and perhaps into and out of hub airports, a very small fraction of the fleet—mostly business aircraft—operates a very large part of the time, in the IFR system. Private, single-engine aircraft operate very little of the time in the IFR system. Most of the time they operate VFR.

I do not have precise figures. They could be obtained by analysis of statistical summaries, published by FAA on an annual basis which indicate by aircraft type and ownership how they are used.

Mr. HELMS. Yes, we have rather extensive data there. To help fill it in for you, approximately 70 percent of all general aviation aircraft have transponders, and the percentage is going up. I agree, however, that by far the majority do not ordinarily use the IFR system. He is exactly correct. Those who use it use it very highly. For example, we have done a study, and a private publication did a study. We came out within plus or minus 1 percent of each other, and found that general aviation uses between 49 and 51 percent of

the total IFR facilities in the country. That is of the IFR flight plans they do. The combination of air carrier, air taxi, DOD, charter, and regional make up the other 50 percent. So some of the people who use the system use it very frequently.

Senator KASSEBAUM. Mr. Helms, you have indicated that the purchase of a mode S transponder will be required for all operations above 12,500 feet by 1990. Is that not correct?

Mr. HELMS. Yes, ma'am. They are required today.

Senator KASSEBAUM. And may be required above 6,000 feet by the year 2000.

Mr. HELMS. Depending upon the population and what happens in the aviation community. Yes, ma'am, it is a possibility. I prefer not to, but if we get so many airplanes up, that would be the only way we could separate them safely, and we would make it a requirement.

Senator KASSEBAUM. What is the altitude requirement for the current mode C transponder?

Mr. HELMS. 12,500.

Senator KASSEBAUM. That is the current requirement?

Mr. HELMS. Yes.

Senator KASSEBAUM. Do you anticipate the mode S would be required for the majority of aircraft?

Mr. HELMS. I do not think that we would make it a requirement—no. In answer to your question, no, Madam Chairman. I do not think that that would be the case. The present thinking is that we are going to probably—I do not want to make this a final decision, but I think what we will do is say, starting in 1986, perhaps 1987, we will take a look at it and see that all new transponders will be mode S. They will have to be, and what that does is, since they both use the same data format, that says that a person who has an airplane with a transponder can use it right on through 1991. Up to that time period he will not have to buy a new piece of equipment, but the person who buys a new airplane after 1986 or a new transponder would buy the new format. He would buy mode S. The cost would be the same, so it would not make any difference. He would have a longer term usage and growth in the new system. But I do not think it is proper to place on the general aviation community the requirement to buy more equipment if we do not absolutely have to have it, and right now I do not think we have to have it.

Senator KASSEBAUM. Have you questions?

Senator EXON. Yes, I do.

Gentlemen, thank you very much for coming. We are very much concerned about the program that you have been working on. I want to compliment you, Mr. Helms, for the NAS plan. I think it is basically a good one. We are getting on the right road as fast as we can. I think you do appreciate, though, that there should be checks and balances as we go along to make sure we are going in the right direction and are not overlooking anything. I would simply say that while we are all concerned about the amount of money this will take today I think the overall aviation requirements in the United States make it most important that we try and devise as reasonable a system as possible, recognizing that, and I think you have indicated, both of you, without saying so today that you do

not see a perfect system where we could eliminate all chances of danger, which is part and parcel of everyday living as we go out and walk across the street.

I just want to suggest as one member of the committee that I am not so much concerned about the cost involved in this as I am developing a system that would serve all of the basic varied interests of our aviation industry. In that regard, I do not believe I heard a comment unless I missed it from either or both of you with regard to any possibility, either now or in the future, for onboard collision avoidance systems. Is that part of your planning? Have you set it aside? Is it worthy of consideration? Where are we on that matter? It has caused some concern and a lot of discussion over the years.

Mr. HELMS. Senator, we have a new system which we have flown and have tested. We now have it installed in some airliners flying, where, for example, we would go to a specific airline and say, we would like to install this equipment to see if it works. If they do not want to, they do not have to; but invariably they are as interested as we are, so we now have a number of pieces of hardware flying regular airline flights, which are solely onboard. That is, they are completely independent of the ground. We have both TCAS 1, the small unit, for general aviation, and TCAS 2, for the air carriers. Both of those have been in the air and flying, and right now our schedule is such that they will be in volume production, probably the first of them, TCAS 1, 24 to 28 months from now, and the second one, TCAS 2 35 to 36 months from now. They are coming along quite well.

Senator EXON. Can you give me a general range of the cost per aircraft of those two systems?

Mr. HELMS. Yes, sir. With one proviso, and that is, what we are trying to do is let the individual owner tailor what he wants. For example, in general aviation, the most fundamental part he would have would probably cost him in the neighborhood of $1,600. That is a proximity warning device, which would include a mode-S transponder and an encoding altimeter. But all that does is flash a warning light to say there is an aircraft within 5 miles of you. If you would like to know where is it, to your right, to your left, or behind you, for another $400 you can put another element in the TCAS that will tell you. If you then want to know whether it is above you or below you, for another $400 you can buy that, and it will say it is over on your right and down below you.

We believe that is the way to respond to the community, let them decide at a fundamental level. If you go the entire route for the small general aviation airplane, our figure is an estimated $3,500. As regards TCAS 2, it is a more sophisticated system. It is a system which can by itself not just react to another one, it can see a TCAS 1, and if the TCAS 1 has the proper equipment—let's say he elected to go all the way, TCAS 2 can literally send a message to TCAS 1 and say, you turn left, I am going to turn right. So therefore we have built in the capability. The pilot, of course, has the final decision. This is not an item which will be done automatically, because you get into all kinds of liability things, but the pilot will make the decision.

That system, TCAS 2, would cost about $55,000. In one trip to London, I visited the insurance market, and the indication I got

from them is, a reduction in insurance premiums alone would pay for this equipment in 7 years.

Senator EXON. Good. Since all of this high technology is way over my head, I would just ask you the question, I do not own an airplane, but if I were to buy one, is there any chance I could use my Atari game?

It seems to me that when we have made such dramatic advances to where we have computers now in homes and Atari games that were far beyond our comprehension 10 years ago, at least for someone like me, that we could not possibly anticipate some major new electronic breakthroughs in this area that could dramatically reduce those costs, or do you think not?

Mr. HELMS. Not in the foreseeable time period. I do not see it even with the curve as steep as it is in long-term integration, improved packaging. I do not see it happening in the next few years. Continually, I am having the problem of getting people to comprehend the magnitude of the systems integration in a particular area. One of the reasons we feel we cannot delay the computer program is, we must start to work now in laying out the fourth generation. We should go to satellites by the year 2010. Therefore, if we wait until 1990 or 1992 to buy the computer programs, we will end up delaying the ultimate capability of the very thing we are talking about available to us after 2000. So these things all interreact. They work back and forth, and there is not a simple answer, but I do not see a major technological breakthrough to bring costs down dramatically.

Conversely, I must say in every case I found the cheapest thing, the best buy the American taxpayer gets is information. The cost of information just reduces drastically.

Senator EXON. Mr. Jenney, do you care to comment on what we have been discussing?

Mr. JENNEY. Mr. Chairman, I don't own an Atari, and I barely understand television. Dr. Shavell might be better equipped to deal with that prospect of what advanced electronics might bring in aviation.

Senator EXON. You obviously do not have grandchildren, or you would have an Atari.

Mr. JENNEY. That is true.

Mr. SHAVELL. What Mr. Helms has said is very correct. The costs of fabricating circuits and electronic components have dropped precipitously over the last 10 years, and those cost curves continue to decline. There will always be something cheaper tomorrow. There will always be something better tomorrow. We have proved historically in our use of electronics that there will be new and innovative ways to apply new electronic technologies as they become available in the future. In the OTA study we have pointed out, and Mr. Helms and the FAA have repeatedly pointed out, that it is important to get on with development and implementation of a replacement for the present air traffic control system, and that it would probably be of doubtful validity to wait for tomorrow or the next day for new technology to come along in the hope that it will bring a major breakthrough. Breakthroughs recently have been less dramatic than in the past; and, as a result, we will not see the big jumps we saw in the early 1060's, for example, when there were

very significant breakthroughs and almost quantum leaps in the technology. Things are moving more incrementally these days.

One of the things Mr. Helms has said repeatedly is that the FAA is designing a system that will evolve and accommodate new technologies as they become available. From the points of view of our study, and from the points of view of the experts we have consulted, this seems to be a very pragmatic approach.

Senator EXON. I thank you very much. I am very impressed with the work you are doing on this, and the checks and balances, and the more minds we have working on this, the better our chance of being successful with the least cost to all involved, the airplane owners and the Government itself.

Madam Chairman, I have no further questions of the panel as a whole. I have something I would like to go into briefly with Mr. Helms as you and I have discussed. Is this an appropriate time to do that?

Senator KASSEBAUM. Sure.

Mr. EXON. Could you enlighten us, Mr. Helms, on the problem with regard to slots in slotted locations where we have high density with regard to the pullout of the Braniff lines? I am speaking specifically of the fact that there is now arising a new controversy with regard to what slots will be given and to whom with regard to the demise at least temporarily of the Braniff route. I am speaking particularly of my State of Nebraska and my sister State of Kansas with regard to Omaha and Wichita and the flights that Braniff formerly made into those cities that have been picked up as I understand it by another airline at the present time, and now it might be that we would have to go to some kind of a lottery to throw that wide open once again. We are back to the situation, I am sure you understand, Mr. Helms, of slots not being directly related to Omaha, Nebr., because it is not a slotted location, but the service to Omaha, Nebr., has a direct bearing on slotted air locations such as Dallas and Minneapolis, and it is all part and parcel of the decontrol.

If there is anyone who has suffered from decontrol, it has been those in the less populated areas of the United States. Therefore, I am hopeful that you can devise some kind of a plan that as we continue with decontrol we do not accelerate the advantages of those who live in the most populated areas. You know the problem of which I am speaking. What can you tell us about it today?

Mr. HELMS. Well, I would want to back up a little, I think, to set the stage, not with an intent to dissuade the Senator from pursuing his point. I became concerned last October about what might happened. I initially drafted out how we would respond to such an event, and stated it in November. On December 10, I formally documented it, and it became a set of guidelines which the FAA would use in the event there was a failure. Most people are not aware of the fact that we have had failures both before and after that until Braniff came along, because that was the only one large enough. In fact, we have had three carriers in addition to Braniff fail, but the system we had allowed it to accommodate itself. That is, the failure was accommodated. When you have one as large as Braniff, obviously, it just could not be done.

The plan calls for, and I have reviewed it as late as yesterday, but there is no way other than to temporarily, if we can confirm that the emergency situation exists, to allocate slots but not routes. The FAA should not be in the route structuring business, and we do not do it. It also requires I be in direct contact with the chairman of the CAB constantly, and I am, routinely, three and four times a day. He and the CAB determine whether there will be a route replacement, and I will then create slots in accordance with what they want.

Now, in some cases, for example, we needed slots at Dallas and Houston, and we needed them from Dallas to Wichita and to Omaha. Some of the carriers, however, demanded they be given the Braniff route. I would not agree with that, because we did not have an emergency throughout the entire area. In the case of Omaha, they lost service. The CAB chairman designated it as an essential service point, and we moved in.

With that background, then, I have no choice but to take the slots out and put those into a normal allocation system, unless the CAB determines that that is an essential service route and it is a requirement for serving the populace, or that if we pull it out it will leave a monopoly. He can make that determination. If the CAB makes that determination, we will not put those slots out and put them in the normal distribution process, because that has priority. Essential service and elimination of monopolies have priority. So, to the extent that he agrees with that, we will not take those slots back. We will leave them there.

Senator EXON. So you are telling me, Mr. Helms, that our principal concern with regard to Wichita and Omaha and those routes should be addressed to the CAB.

Mr. HELMS. Yes, sir. Unfortunately, I would like to give you a positive response, but we do not get into the route business. The FAA should not do that. I want to get out of slot allocation.

Senator EXON. All right. Let's follow up on one point. Explain to me, if you will, how this lottery works. As I understand it, at least from what you have programed earlier, in some cases you would go to a lottery when there is a slot open so that everyone could draw for that slot, and it would be possible, for example, if there is a slot open in Dallas, Tex., for an airline that does not even fly north or south to get that slot, possibly even an airline that does not fly into Dallas. Is that possible?

Mr. HELMS. Yes, sir, it is.

Senator EXON. That is not a very good system, is it?

Mr. HELMS. It is not in my view directly responsive to the needs of the traveling public. However, at the time we initiated it, in January, we did so because we were recovering capability in the handling of aircraft. Up until that time it had been first come, first served, and as you recall, last October I made the decision to cut down on the number of flights, to give our people rest during the winter. It is nice to have hindsight, but in fact that is the worst winter we have had in this country for half a century. Thank gosh we cut it down. From January, though, when we could expect an increase, I was of the view the FAA should not be in this business. It is not our job. We ought to get out of it, deregulate, so the only system we could come up with was a lottery. You take your chance.

Since that time, we have now had that process underway, and there is pretty much agreement that is not directly responsive to the needs of the traveling public. Now we have gone out and issued a notice, and are receiving comments from people as to how this system should be. We have had requests, and yesterday I signed an order extending the comment period to July 15. Out of that will probably come a new system, but I cannot say with certainty, Senator. I want us to respond to what the traveling public needs, and the CAB is the agent that should in fact designate a small community that needs service, and they will get a slot at O'Hare, and give it to them. If they say that to me, fine. We will give them the slot.

Senator EXON. Thank you very much. I will follow up with you and the CAB.

Mr. HELMS. I am sure you will, Senator.

Senator KASSEBAUM. Thank you, Mr. Helms, Mr. Jenney. I appreciate your testimony. It has been very valuable. The more we can work together in explaining and discussing this really very important plan for the future of aviation, the more the benefit.

Mr. HELMS. Thank you, Madam Chairman.

Senator KASSEBAUM. The next panel includes Mr. Ralph, Mr. Warner, and Mr. Snodgrass. It is a pleasure to welcome you here this morning, Mr. Ralph, senior vice president, operations and airports, Air Transport Association, Mr. Warner, vice president, Aircraft Owners and Pilots Association, and Mr. Snodgrass, director, aviation programs, Aerospace Industries Association.

Mr. Ralph, would you begin?

STATEMENTS OF JOHN RALPH, SENIOR VICE PRESIDENT, OPERATIONS AND AIRPORTS, AIR TRANSPORT ASSOCIATION; ROBERT T. WARNER, VICE PRESIDENT, AIRCRAFT OWNERS & PILOTS ASSOCIATION; AND JOSEPH C. SNODGRASS, DIRECTOR, AVIATION PROGRAMS, AEROSPACE INDUSTRIES ASSOCIATION

Mr. RALPH. It is a pleasure for me to be here today to offer our views on the FAA's national airspace system plan. I will limit my verbal remarks to a few issues, recognizing that the prepared statement has been accepted for the record.

Senator KASSEBAUM. Thank you.

Mr. RALPH. My first series of comments focuses on why the ATC system needs to be modernized, and why it needs to be modernized now. Over the next decade, aviation activity is forecast to increase significantly, particularly the number of IFR controlled operations. Attachments 1 and 2 to my prepared text illustrate what we consider the most relevant forecasts. We believe the FAA forecasts are reasonable, and attachment 3 to my prepared statement provides our analysis to support that conclusion.

Besides growth, modernization is needed for reasons of hardware reliability and efficiency. It is important to replace the 20-year-old ATC hardware that is difficult and costly to maintain. Keeping these old computers in spare parts alone is becoming progressively a more difficult task with the passage of time. The GAO in its report of December 15, 1980, entitled "Continued Use of Costly Outmoded Computers in Federal Agencies Can Be Avoided," has

made the most persuasive case for modernization, and I recommend it to you for review.

Modernization is required to overcome software limitations. The 9020 software has become convoluted, and its rework and maintenance is excessively burdensome. In addition, the new ATC services which are needed cannot be accommodated until new high order software is available. Modernization is needed now because both the users and the Government need the benefits of greater productivity.

The FAA believes that in the future, perhaps 10,000 controllers could handle the job that might otherwise require a work force in excess of 25,000. The airlines see the opportunity of capturing a 2-, 3-, or 4-percent fuel savings through increased ATC efficiency. When you consider our fuel bill in 1981 was in the order of $10.5 billion, and represented 30 percent of our operating expenses, even a small percentage savings is significant.

Let me interject a few comments on computer capacity. The FAA uses the concept of an operational delay day. An operational delay day is one in which processor utilization exceeds 80 percent after all nonoperational functions have been turned off, so the question is what is turned off. Training and data recording or history files is what is turned off. On this basis, the FAA projects a conservative need for additional capacity.

I fear this approach to computer capacity does not take into account the very heavy training load the FAA will continue to have for a long time in the future. I do not believe the FAA can afford to shut down training in the future as it has in the past. Not only must it train replacements for the thousands of controllers who went on strike illegally last year, but another challenge will face them shortly. There are a few hundred senior controllers now working who are eligible to retire but have stayed on to help the FAA through this crisis.

Recently, an FAA official said that over the next couple of years, those eligible to retire will grow to approximately 1,600. I do not believe the ATC system can afford to shut down training, and when rating ATC system computer capacity, the training load should be included.

I believe that consideration of safety requires the continuous recording of history files. Any time there is a system error when safe separation is violated, the history files are needed to recreate the circumstances, so that corrective action can be taken. Without the history files or an audit trail, if you will, attempted corrective action is based upon supposition and could be contentious. The need for data recording should be a part of the rated capacity. Certainly the ATC system of the future needs to meet these capabilities continuously without interruption due to traffic load.

It has been suggested that perhaps the FAA should postpone modernization until the next decade, and as an interim measure replace 9020A computers with the more capable 9020D. I believe this option is one with no redeeming virtues, and my attachment 4 develops our reasoning in that regard. Suffice it to say now that conversion does not increase capacity enough to provide for additional ATC services needed. Conversion does not accommodate new high-order software. Conversion would cost somewhere, it has been

estimated, from $60 million to $100 million for 20-year-old technology which would continue the problems of reliability and availability, problems of spare parts and manpower, intensive maintenance, and low productivity. And you still have to modernize a few years hence.

The system architecture the FAA has selected for modernization uses the distributed processing concept and the interim hosting of the 9020 software. We believe this to be a viable technical approach, because it is an efficient solution to provide the massive computational abilities needed for the advanced ATC system. It minimizes the technical risks associated with both the new hardware and software technologies. It provides for a near transparent accommodation to the new system by controllers, and it will deliver the benefits of new technology somewhat sooner than other options.

Before closing these remarks, a few comments addressing the management challenges facing the FAA are appropriate. Although the hardware issues are important, we believe the most formidable challenges facing the FAA in this endeavor are managerial. We believe the FAA needs to adopt some new managerial organizations and tools to insure timely and economic execution of the plan. Some steps have already been taken, and some new steps have been identified this morning. We see additional needs. We see a need for a management, information, and reporting system. We see a need for a management control center or office, and we believe the Advanced Automation Program Office, which has been referred to, should grow into a comprehensive system program office having cognizance over the entire modernization effort.

Thank you, Madam Chairman.

[The statement of follows:]

STATEMENT OF JOHN E. RALPH, SENIOR VICE PRESIDENT, OPERATIONS AND TECHNICAL SUPPORT, AIR TRANSPORT ASSOCIATION OF AMERICA

Madam Chairman and Members of the Committee, my name is John E. Ralph. I am Senior Vice President, Operations and Technical Support of the Air Transport Association of America, which represents scheduled air carriers. It is a pleasure to be here today to offer our views on the FAA's National Airspace System Plan.

AIRLINE VIEWS ON THE FAA PLAN

On May 24, just one month ago, Paul R. Ignatius, ATA President testified before this Committee to support the approach this Committee had developed to overcome the impasse on the important airport and airway authorization bill. Mr. Ignatius commented on the National Airspace System Plan as follows:

"The airlines have long supported the modernization of the ATC system in order to reduce congestion and delays and to insure above all else that the airways will be operated at the highest level of safety attainable. In our view, prompt modernization is essential".

I want to restate our support for the objectives and fundamentals of FAA's National Airspace System Plan, and for a companion program of improvements to airports serving the nation's air transportation system.

Before embarking on a discussion of specific issues and challenges associated with the National Airspace System Plan let me offer the following related comments:

The airlines and other users should participate in a continuing review and further refinement of the Plan in order to insure that necessary supporting and coordinating actions will be taken in a timely way and that actions taken by the FAA are related to capabilities of the users to respond.

While additional cost information has been provided in recent weeks, longer range and more complete cost estimates are needed, including projected costs to

users. The Plan estimate should also contain an analysis of other factors that could affect ultimate cost, such as the degree of technical risk associated with various elements of the Plan and the need for further development of the concepts employed in the system's architecture. Some large projects of this kind often end up costing far more than anticipated, the possibility of substantial overruns must be considered with some idea as to how the problem will be handled should this occur.

The system acquisition strategy is a factor, along with the technical concept and the cost estimate, that must be carefully considered if the Plan is to meet its technical, cost and schedule objectives. While FAA has purchased major items of equipment for a number of years, the Plan involves the acquisition of an integrated system that goes far beyond anything that FAA has attempted before. The Administrator is aware of this aspect of the matter and has established a special program office to help manage the acquisition of the ATC replacement computer. It is extremely important that this office be adequately staffed and funded, and cloaked with the necessary authority to get the job done. In addition, to help manage all of the system improvements, the FAA is reconstituting the Aviation Systems Acquisition Review Committee under the direct supervision of the Administrator.

With these general comments behind us, let me turn to the discussion of several subjects of particular relevance.

EXPECTED GROWTH IN AVIATION ACTIVITY

The National Airspace System Plan is needed to accommodate the growth in aviation that is expected in this decade through the planning period to the year 2000. FAA expects that:

IFR traffic will increase 50 percent in the next 10 years.

The number of air carrier aircraft will increase only modestly from the present 2,500 or so during the next 10 year period, since growth in passengers will be accommodated by larger aircraft and improved utilization. Commuter and air taxi aircraft are expected to grow at a somewhat higher rate.

The major source of growth will be in the general aviation category. This heterogeneous grouping now totals about 200,000 aircraft and will grow to about 300,000 by 1990. Within this grouping, business aircraft, now numbering about 65,000, are expected to reach 100,000.

Attachment I, appended at the end of my statement, portrays the projected increase in the numbers of aircraft that will be handled by the FAA Air Route Traffic Control Centers.

Attachment II takes this data and coverts it to show the proportionate IFR load on the ATC centers in percentages by type of user. Air carrier aircraft today account for about 44 percent of the load; in the early 1990's the percentage will decline to 37 percent. General aviation aircraft, on the other hand, now account for about 29 percent of the IFR load, but in the early 1990's are expected to account for over 39 percent. Thus, within the next decade, the present positions will be reversed, and general aviation will be imposing a heavier load on the system than will air carriers. The commuter and air taxi percentage of use increases only modestly, and the military percentage of the total load declines.

The airlines believe the most relevant workload measurement, and hence the most relevant forecast, is the number of IFR aircraft handled by the FAA Air Route Traffic Control Centers (ARTCC's). Attachment III presents detailed analysis of FAA forecasts of the IFR aircraft handled at the ARTCC's. The analysis demonstrates that the FAA has done a respectable job on these forecasts.

In our opinion, there will be significant aviation growth over the next decade, and it is clear that the current ATC system cannot accommodate that growth. The prior Adminstration, looking at this anticipated growth, suggested, to the consternation of the aviation community, that the necessary airway and airport facilities might not be available to handle such a significant increase. The new FAA Plan, with a more positive approach, is intended to provide the requisite airway facilities to accommodate this growth.

MODERNIZATION

In addition to the need to accommodate growth, there is a concurrent need to modernize the ATC system. The present system is based upon computers of an earlier generation that have been overtaken by more modern solid state technology and other advancements. Maintaining these computers at a satisfactory level of reliability and obtaining the necessary spare parts is becoming progressively a more difficult task with the passage of time. The present ATC mainframe computers have very little growth potential and cannot accommodate higher orders of automation

necessary to implement advanced enroute air traffic control programs. Thus, even if growth in demand materialized at a slower rate than forecast, there would still be an overwhelming need for modernization.

OVERCOMING SOFTWARE LIMITATION

To enhance safety and to capture the benefits of increased user efficiency, improved controller productivity, as well as reliability and availability, requires both new hardware and new high order software. The 9020 software is over 10 years old and has been modified extensively. The 9020 software was inherently very complex, and that complexity has increased over time as new functions have been accommodated and other changes made. The software has become convoluted, and now each new version or modification causes a chain reaction of effects that must be resolved through additional patching of the software.

In addition to the burdensome maintenance requirements of the current software, the flight data processing and the data structures in the 9020 software will not accommodate the addition of the highly beneficial functional improvements scheduled for the future, namely fuel-efficient route planning, and flow planning and advanced enroute metering. These functions are the first of the so-called AERA functions (Automated Enroute ATC system) which will give the users much greater efficiency in the use of airspace with resultant economies in fuel burn and delay reduction.

In 1981 the airlines spent about $10.5 billion for fuel, and this represented about 30 percent of our operating expenses. Although the price of fuel stabilized and even declined in early 1982, we are now seeing upward pressures in prices again. I know of no one who does not agree that fuel prices will increase in the years ahead. The opportunity to capture a 2- 3- 4-percent fuel saving through increased ATC efficiency therefore carries significant implications for airline economic viability.

IMPROVED PRODUCTIVITY

The enlarged and modernized ATC system will also be far more productive for the government. By substituting investment in facilities for expansion of the controller work force, the FAA Administrator has estimated that perhaps 10,000 controllers could handle the job that might otherwise require a work force in excess of 25,000. Thus, the Plan provides greatly increased labor productivity and permits a signficant avoidance of personnel costs on the part of the government.

The Plan also envisions other means of improved efficiency and productivity through reduction and consolidation of many present facilities. The domestic centers, for example, would be reduced from 20 to 16 and flight service stations from 317 to 61.

HOST COMPUTER SYSTEM ARCHITECTURE

We believe the approach taken by the FAA to make use of the distributed processing concept and interim hosting of the 9020 software in the mainframe replacement computer and the advanced sector suite is a viable technical approach. It will provide a near optimum solution for the requirement to provide massive computational capability for the advanced ATC system, and it will minimize technical risks associated with the implementation of new high order software.

The host concept provides for minimum risk transition from the current 9020 system to the new technologies, both hardware and software related. Hosting will provide for a near transparent accommodation to the new system for the controller. That is to say, except for a changed hardware configuration and new system services, the procedures and techniques of the controller will be the same whether operating in a pure 9020 environment, a host with 9020 software environment, or the new hardware with the new software environment.

The ability to proceed in a deliberate fashion to the new piece of hardware with old software, and then change out the software while the 9020's are still functional provides a safety net for the FAA to cope with unforeseen events such as delivery or schedule slippages, technical hurdles with the new software, or other unforseen difficulties. This hosting option is the one option that minimizes risk.

The host computer approach will provide the benefits of new technology somewhat sooner than if FAA replace the complete mainframe system. The new technology benefits include greater reliability and availability. In some cases added capacity will come on line as much as 3 years sooner than with other options. This added capability will primarily aid controller productivity, but users will benefit indirectly.

Some have suggested, as an alternative to modernization now, the upgrading/replacing of 9020A computers with 9020D's, and postponing the acquisition of new systems for another decade. The FAA replaced some 9020A's with 9020D's in the past, the last conversion being at the Jacksonville ARTCC. Thus, there is no question about the technical feasibility of such an approach. However, we believe this to be an unwise approach in the future for a variety of reasons, which are developed fully in Attachment IV. But, to summarize briefly here:

Conversion does not increase capacity enough to provide for additional ATC services needed.

Conversion does not accommodate the new, high order software.

Conversion does not improve reliability and availablility.

Conversion does not alleviate the problem of spare parts support and manpower intensive maintenance which would persist and intensify with time.

Conversion does not result in higher controller productivity.

Conversion would cost $100 million and within a few years it still would be necessary to undertake modernization.

MANAGEMENT CHALLENGES

We believe the most formidable challenges facing the FAA in implementing the National Airspace System Plan are managerial in nature.

Organizing for effective management

Organizing properly to take on this 20 year program will be crucial to insuring timely and economic execution of the plan. From previous FAA testimony, it appears that the Advanced Automation Program Office is primarily focused upon the host computer and the full system replacement including the controller sector suite and their immediate ancillary programs. Additionally, we see a need for a single, comprehensive management information and reporting system and a single management control center or office that can be used by the Administrator and his Aviation System Acquisition Review Committee (ASARC) and the program manager.

The challenges of effectively managing such a long-lasting and complex undertaking may make it necessary for the FAA to institutionalize a true system program office providing full executive authority over contract specifications, performance, schedule and budget. In this regard, as the Advanced Automation Program Office matures, perhaps it could take on additional management functions and eventually evolve into a comprehensive system program office having cognizance over the entire modernization effort.

Computer replacement schedule

As has been made clear in earlier comments, the key to obtaining the increased capacity, modernization and increased productivity is the replacement of the ATC computers. However, the proposed schedule for the host computer appears to us to be both time consuming and expensive. The FAA Plan calls for acquisition of two competitive host systems to be followed by a one year side-by-side run-off at the FAA Technical Center. The production award would be made in 1985 provided there is no schedule slippage. The present acquisition strategy seems to postpone the production commitment to such a late date that there is a risk of impeding sector suite development. While a competitive procurement is certainly necessary, it may be worth exploring alternatives to see if competition can be achieved while consuming somewhat less time.

With respect to the full replacement system, the FAA portrays an R&D contract award in 1983 with a prototype demonstration of the new sector suite in 1985 and contract award for the full system including hardware and software.

When one lays this schedule against the system architecture the FAA has portrayed for the advanced automation program, we see the potential for difficulties. The system architecture calls for distributed processing between the mainframe computer (host) and the sector suite. The advanced software programs will be partitioned to run in the host computers and the sector suite. Universal data busses utilizing standard protocols will allow the sector suites to access all necessary information shared with other systems. Simply speaking, these systems must enjoy the most intimate interrelationships. It also means the the host-sector suite is the critical link in the FAA Modernization Plan.

We believe the crucial interdependence of the host computer and the full replacement system, including the sector suite has been somewhat obscured by the fact that they have been portrayed as independently manageable subsystems. We also believe the new capabilities offered by the host and the sector suites may be needed earlier than implied by the Plan.

Software management

Most discussion of this Plan has centered on hardware issues. In contrast to this, the major challenges and risks are more likely to be associated with the management of the new, high order software packages that are to be hosted in the advance computers. The FAA has 11 functional programs that are contemplated for possible inclusion in the advanced ATC system. The state of maturity of these programs ranges from several that are ready to be implemented now in the 9020's, to some that are in demonstration test beds, to some that are essentially conceptual in nature. Even though several can be implemented now, or in the new host computer using today's 9020 software, most will have to wait for the new, high order software capability before they can be implemented.

It should also be remembered that the management challenge of rehosting the existing 9020 software in the replacement computer and then developing new, high order software downstream is a formidable task in and of itself.

Transition planning

Careful transition planning is clearly important for both the host and the advance sector suite computer systems and the new software. To change system software while still operating the Air Traffic Control system will be a major undertaking. We understand that consideration is being given to a transitional role for the enhanced DARC (Direct Access Radar Channel). We recommend that a comprehensive transition plan be developed which would include not only the replacement of hardware and software but also take into account the magnitude of human engineering problems which can be ancitipated.

Careful transition planning is also needed for other FAA actions—the consolidation of ATC facilities, the new communications system, incorporation of Automatic Enroute Air Traffic Control (AERA), and data link between ATC and aircraft warrant special attention.

User consultation

FAA plans for MLS acquisition serves as a good example to highlight why close consultation and coordination will be needed between users and the FAA.

As MLS is introduced, users wishing to exploit this capability will have to install new MLS receivers in their aircraft, but will have to retain their ILS capabilities as well. The MLS implementation schedule needs to be well integrated with user equipment acquisition plans. Since users will have to maintain dual capability for an extended period of time anyway, the FAA should be very circumspect about decommissioning fully capable and reliable ILS facilities for no other reason than to install MLS. While we support the implementation of MLS, we do not support the decommissioning of ILS facilities simply because a certain date appears on the calendar. The ILS is a proven, reliable part of the national airspace system and the air transport network. We question, on economic grounds, whether or not it is a good business decision to immediately replace ILS with another system, except at locations where ILS does not perform reliably, or at other locations where ILS could not be installed due to siting problems. Users continue to invest significant funds for airborne ILS equipment. There is a heavy investment being made to upgrade approach and landing capabilities to Category III operations. The users need to retain existing facilities and upgrade others to appropriate standards in order to realize a fair return on these investments.

Another example where close user consultation will be required is in the acquisition of the MODE-S transponder and its variants that include data link and traffic alert and collision avoidance systems.

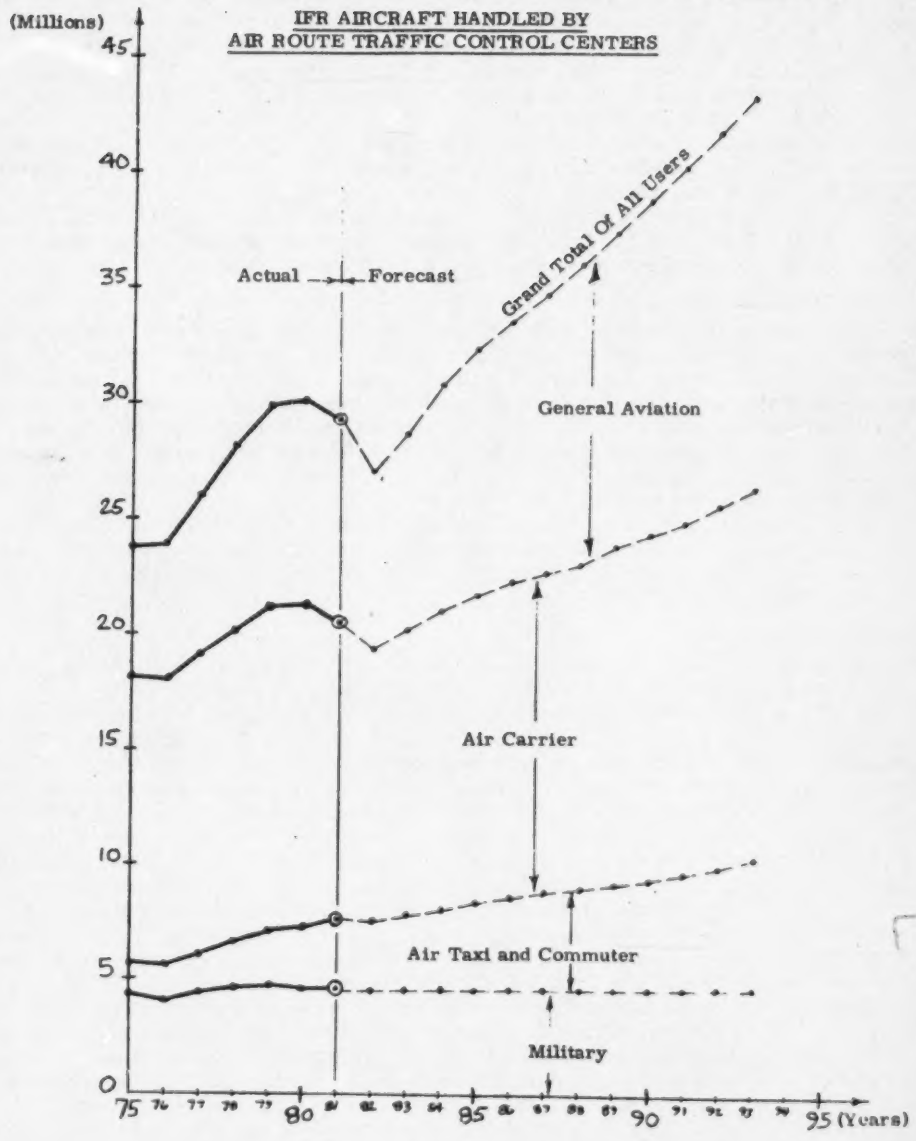
SUMMARY

In summary, we support the FAA Modernization Plan in priciple, while stressing the importance of full consultation by users with the FAA on details. We believe the ATC system must be modernized, above all else, to insure safety of flight into the next century, as well as to provide necessary capacity and productivity improvements to both users and the FAA.

The challenges facing the FAA are formidable but we believe that recognition of their magnitude can lead to resolution of issues through effective and sustained management direction.

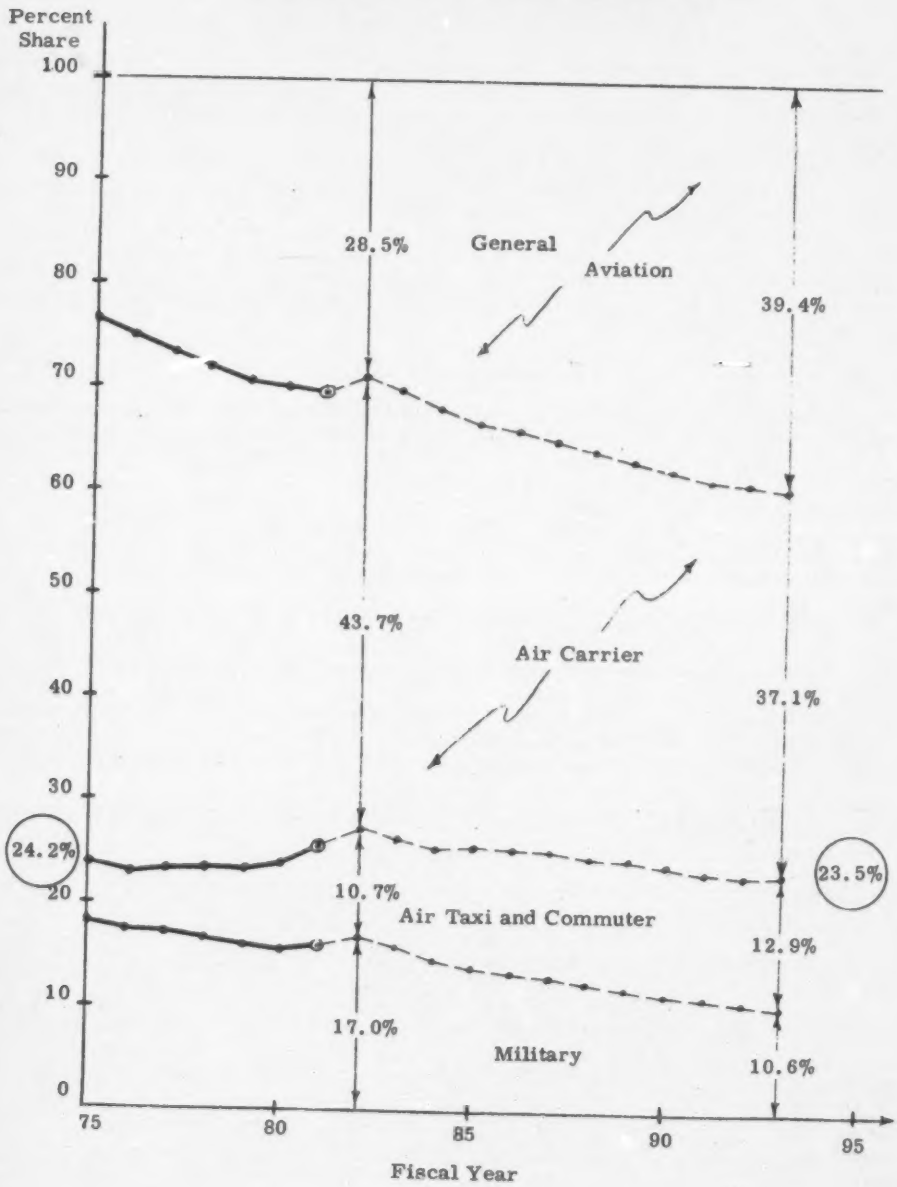
That concludes my prepared remarks. I am now ready for your questions.

ATTACHMENT I



ATTACHMENT II

FAA FORECAST OF PERCENT SHARE FOR EACH USER TYPE OF IFR AIRCRAFT HANDLED AT FAA AIR ROUTE TRAFFIC CONTROL CENTERS



ATTACHMENT III

COMPARISON OF FAA FORECASTS VERSUS ACTUAL LEVELS FOR IFR AIRCRAFT HANDLED AT FAA AIR ROUTE TRAFFIC CONTROL CENTERS

Table I on the following page is a summary tabulation of the last twenty years of FAA industry forecast reports of how their projections of IFR aircraft handled at FAA Air Route Traffic Control Centers (ARTCC) compares to the activity levels that actually occurred, along with the percentage these forecasts were over or under the actual levels.

Two notes about this table need to be observed:

(1) Since in the early to mid 1960s, the FAA only forecast six years into the future, this time span was kept constant for all the forecast comparisons in order to be fair in tracking the FAA's record. In other words, comparing a 12-year time span forecast made in the 1970s with a 6-year time span projection made in the 1960s is not valid, since the object is to track the FAA's record over the last twenty years of developing forecast reports on a consistent basis.

(2) Fiscal year 1980 was the last "actual" year used in the forecast comparison, because part of 1981 was significantly affected by the air traffic controllers distruption. Since this artificial capacity constrained situation is only temporary over the longer term, it is only proper to use a normal "demand" condition to compare the forecast numbers against.

ANALYSIS AND CONCLUSION

On the whole, the last twenty years of FAA forecast reports have been quite reasonable. In the early 1960s (1960–1964), they forecasted less than what actually occurred by 31.2% on the average. In the latter 1960s (1965–1969), their forecasts were high by an average of 15.7%. However, in the early 1970s (1970–1974), their average was high by only 5.5%. In the last five year period (1975–1979), the FAA forecast were low by only 0.2%. (Of course, the last five years of projecting were only averaging 3 years into the future, because 1980 is the last year of history in which to compare, as compared to the 6-year projections in the preceding 15 years of forecast reports.)

In calculating the percentage difference between all twenty FAA forecast reports developed between 1960 and 1979, their 6-year projections for the first 15 years and 3-year average projections in the last 5 years, were, in the aggregate, off by only six tenths of one percent!

In conclusion, it is our observation that the FAA forecasts have been quite reasonable and that they have become more accurate in the last decade, probably as a result of increased sophistication by using econometric forecasting techniques.

TABLE I.—COMPARISON OF FAA FORECASTS [1] VERSUS ACTUAL LEVELS FOR IFR AIRCRAFT HANDLED AT FAA AIR ROUTE TRAFFIC CONTROL CENTERS

FAA forecast report date	Base year	Forecast year (fiscal year)	Number of years forecast	Forecast (millions)	Actual (millions)	Percent each forecast over or under actual (percent)	5 year average percent forecast over or under actual (percent)
November 1960	1960	1966	6	10.9	13.5	(−19.3)	.....
October 1961	1961	1967	6	12.1	15.1	(−19.9)	.....
November 1962	1962	1968	6	12.6	18.1	(−30.4)	(−31.2)
December 1963	1963	1969	6	11.6	20.6	(−43.7)	.....
December 1964	1964	1970	6	14.0	21.6	(−35.2)	.....
December 1965	1965	1971	6	19.3	21.3	(−9.4)	.....
January 1967	1966	1972	6	22.4	22.0	+1.8	.....
January 1968	1967	1973	6	29.9	22.8	+31.1	+15.7
January 1969	1968	1974	6	29.1	22.9	+27.1	.....
January 1970	1969	1975	6	29.6	23.6	+25.4	.....
January 1971	1970	1976	6	28.9	23.9	+20.9	.....
September 1971	1971	1978	6	27.5	26.0	+5.8	.....
September 1972	1972	1978	6	30.5	28.1	+8.5	+5.5
September 1973	1973	1979	6	28.9	29.9	(−3.3)	.....
September 1974	1974	1980	6	29.8	30.1	(−1.0)	.....

TABLE I.—COMPARISON OF FAA FORECASTS [1] VERSUS ACTUAL LEVELS FOR IFR AIRCRAFT HANDLED AT FAA AIR ROUTE TRAFFIC CONTROL CENTERS—Continued

FAA forecast report date	Base year	Forecast year (fiscal year)	Number of years forecast	Forecast (millions)	Actual (millions)	Percent each forecast over or under actual (percent)	5 year average percent forecast over or under actual (percent)
September 1975	1975	1980	5	29.0	30.1	(−3.7)	.....
September 1976	1976	1980	4	28.9	30.1	(−4.0)	.....
September 1977	1977	1980	3	30.5	30.1	+1.3	(−0.2)
September 1978	1978	1980	2	31.1	30.1	+3.3	.....
September 1979	1979	1980	1	30.7	30.1	+2.0	.....
Average				24.4	24.5	(−0.6)	.....

[1] Source: 20 FAA reports "FAA Aviation Forecasts" for various fiscal years.

ATTACHMENT IV

WHY UPGRADING 9020A'S TO 9020D'S IS A BAD IDEA

The 9020A mainframe computer is based upon aggregating a number of 360/50 computers, whereas the 9020D is based upon the 360/65 computer for its computational and storage modules. Using verbs like "upgrade" and "modify" carries false impressions. It is more accurate to talk about "replacing" 9020A's with 9020D's. This was last done at the Jacksonville ARTCC a number of years ago. A new 9020D installation was procured from IBM and the 9020A equipment was relegated to supporting FAA's flow control management effort.

To configure a 9020D requires 3 modified 360/65's for the computational subsystem and 4 modified 360/65's for the storage subsystem. Therefore, to replace the 9020A's in the 10 centers equipped with them would require the acquisition of 70 IBM 360/65 computers from surplus or the used computer market since none are being produced. We understand there are 103 IBM 360/65's in federal inventory of which 13 are surplus. IBM has reported that there are probably 100–200 360/65's still in use by industries and universities.

If the basic problems of procuring 70 aged 360/65's are overcome, you are then faced with the requirement of insuring that all are reconfigured to the same engineering design level. The unique engineering changes that have been made would have to be reworked out and all brought to the same standard configuration. But, you still do not have a 9020D simply because you have 7 IBM 360/65's. The physical packaging into a D must be accomplished. Racks, cables and cabinetry must be manufactured. The 360/65 compute element must be modified with a read only memory. The power requirement of the 9020D configuration is different from the 360/65. This replacing of 9020A's with 9020D's would cost in the order of $100 million, and the first conversion would not take place until 1985.

If one were to do this, what would you have accomplished? It is true that some increase in capacity would result and that some of the new ATC services could be provided. However, you would still have a system based upon 20-year-old technology, and system and component reliability and maintainability would not be improved. Spares support difficulties would increase with time and labor-intensive maintenance would continue. Capacity and software limitations would still remain, precluding major efficiency gains for users and productivity gains for the FAA. Then, at some future time, in the order of 5 to 7 years, this $100 million effort would have to be thrown away and a new modernization effort would have to be undertaken to get the state-of-the-art hardware and software required to provide the services that would have been held in abeyance for a decade.

A major objective the airlines expect to accomplish by supporting the ATC modernization plan is to reduce the costs of operation as a result of implementing AERA services, the first program of which is direct fuel-efficient route planning. AERA cannot be accommodated without new, high order software and without a new ATC computer system. The airlines will not support increased user charges for such a heavily compromised approach as replacing 9020A's with 9020D's represents.

Senator KASSEBAUM. Thank you, Mr. Ralph.

Mr. Warner.

Mr. WARNER. Good morning, Madam Chairman. My name is Bob Warner. I am the vice president for ATC, airports and airspace of the Aircraft Owners and Pilots Association. I believe you are very familiar with our organization. We represent over 260,000 pilots nationwide, both pilots and aircraft owners. We represent the group of individuals who will be most affected by the FAA programs we are discussing here.

Our president, John Baker, sends his regards and regrets he could not be here today. He is out of the country.

AOPA testified before this committee on May 24, and we went into quite a bit of detail about the FAA 20-year plan at that time. I will not reiterate that position today, only reinforce that the comments made at that time still hold true. Since then, we have been characterized as the good guys and the bad guys by different individuals and different reporters. As a part of our testimony today, which I hope will be made a part of the record, we have detailed the 97 programs within the FAA 20-year plan, and listed whether we opposed or supported those subprograms.

I think a quick look through our testimony will indicate that indeed we support more programs than we oppose. Where most of our opposition comes is in the area of the funding of the program. We are concerned about the funding of the program in advance and foreclosing some actions or decisions that would be necessary in the latter 15 years if indeed a majority of the subprograms take place within the next 5 years.

Our reasons for opposition of the funding of the program in its totality are threefold, and as a preface to that, of course we have strong feelings, as I am sure the committee knows, of the FAA financing their operation 75 percent before we even start paying for the needed modernization of the air traffic control system.

The three basic problems we have with the funding of the program in its totality are, it has been incorrectly termed as a systems approach, second, we still, after this morning's comments by the Administrator, have some concern that the plan dictates future equipment requirements, and that, third, the plan is actually a collection of stand-alone programs, many of which need to have their own analysis and approval by the users and funding approvals by the Congress.

The FAA has represented that there is basically concurrence by the aviation industry for the entire plan in concept. Those are the important words. We too, AOPA, agree and would be the first to know that there is a need for improvement in the system. We are in it considerably. However, to represent that we, AOPA, and general aviation are in support of the entire system is a bit of an exaggeration. We have been involved in the deliberations on many of the subprograms discussed as a part of the plan. We have been involved in the MLS development over the course of the years. We currently have the position of opposition to the MLS program. We have also been involved in the development of the modernization of the flight service station network, which has now been made a part of this bigger brown book.

Our earlier positions on a number of subjects have taken on a new light as a result of the plan also. For example, we now question the need for 25 kilohertz VHF communications equipment on board aircraft when many of the concepts detailed in the plan, such as sector suites and the consolidation of facilities and control sectors would appear there would be less congestion on the frequencies. Also, the closure of a number of air traffic control towers would appear to give relief in the frequency congestion problem.

The second fallacy of the FAA plan is, it does not dictate future airborne system requirements. I was on the verge of being excited this morning when the Administrator mentioned there would be no impact on VFR flying as a result of the plan. But his words were very carefully chosen, and I think we need to spend a few moments discussing both the national airspace review, only in its third week of a 42-month effort, and also general aviation's use of the system, and how much it flies VFR.

I would concur with the earlier testimony that general aviation flying is in the majority, VFR. In fact, our analysis of FAA statistics indicates that 90 to 95 percent of general aviation flying is VFR. However, it is important to realize that VFR flying requires the aircraft to go into airspace often that has been regulated by the FAA to have certain equipment requirements. Part of that is the airspace above 12,500 feet and certain terminal control areas, which currently require mode C transponders.

I have flown my aircraft twice this week, once to JFK and once to Washington National this morning. Both flights were conducted VFR, both were completely outside the air traffic control system, until I arrived at the edge of the terminal control area. At that time, I was required to have certain equipment on board. We have been told that many of the decisions on rulemaking equipment requirements and procedures will be discussed in the National Airspace Review. If the Administrator's statistics are right, and 98 percent of the NAR is input from the aviation community, then I would suggest that 100 percent of the output will be FAA's. We have now participated in 2½ weeks of discussion nonstop about terminal control areas, a very specific subject within the air traffic control system.

We are aware of the fact that the FAA has a want list of what they would like to see the result of that committee be, and even though the majority of the individuals sitting on that committee are members of the aviation community and not the FAA, the fact is, we are concerned that the end result will reflect what the FAA wanted prior to the start of the NAR rather than what the users believe is necessary.

A plan released in January of this year which mentions that certain equipment will be required to fly IFR in this system by the turn of the century, such as a microwave landing receiver, a mode S transponder, and possibly TCAS equipment. AOPA is concerned that decisions will not be made 42 months from now as a part of user participation in the NAR, but rather, those decisions have already been made.

It is easy to say there will be no effect on general aviation or VFR flying if there is not significant demand above 6,000 feet or above 12,500 feet or in certain terminal areas. However what the

FAA is saying is, if their forecasts are incorrect, there will not be an impact on us. If they are correct, the implication is, there will certainly be impact on us. AOPA has determined that the equipment requirement I just listed, the MLS receiver, the mode S transponder, and the TCAS equipment, all of which we are involved in the development of specifications for and have commented on rulemaking process for, would cost approximately $10,000 per airplane. So someone who wants to continue to operate in the instrument system and fly IFR and get full utilization of their aircraft for business or personal transportation will probably have to spend $10,000 on this equipment.

Assuming the FAA's estimates are correct, there will be about 200,000 airplanes which will desire to be in this system by the turn of the century. That is $2 billion—billion, with a b—and possibly even $3 billion, since some aircraft are required to have dual sets of equipment.

The final contention we have is that the national airspace system plan is actually a collection of stand-alone programs that deserve the individual review of all of us in the industry, that of Congress with approval or disapproval. Some of the programs, the flight service station modernization program I mentioned earlier, have become subsets of the brown book. Those programs, specifically, flight service station, has been under way for years. I would suggest that it is important for us to review that program as it goes along and consider the fact of what budgetary constraints and the fiscal situation at the time has on decisions already made. The flight service modernization program was discussed at great length in many different congressional committees in years past. Decisions were made there. Suggestions were made to FAA. Plans were modified, and plans are now in the implementation phase as the Administrator pointed out. Unfortunately, they are not going as rapidly as possible.

We appreciate the opportunity to be here and talk to you today. AOPA suggests that there is a need for both technological and funding flexibility in this plan, and we would give as an example to that the situation in the FSS program. Decisions were made earlier, as I mentioned. Funding has been provided on a year-by-year basis, and as various budgetary constraints have come about, the flight service stations have been one area cut out.

A review of the fiscal 1983 FAA budget shows they intend to consolidate or close over 100 flight service stations. There is not a single automated FSS that will be brought on line during fiscal 1983, according to the FAA's budget request, Some of the stations that will be closed are in your State, Madam Chairman.

So, we would suggest that there is a need to not press forward with an entire plan for the very reason that this FSS program has been an example. There is a need for flexibility as a result of budgetary constraints and, as has been discussed earlier today, as technological advances show us there is something a little better. Thank you very much.

[The statement follows:]

STATEMENT OF ROBERT T. WARNER, VICE PRESIDENT, AIRCRAFT OWNERS & PILOTS ASSOCIATION (AOPA)

Madam Chairman, I am Robert T. Warner, Vice President, ATC, Airports and Airspace of the Aircraft Owners and Pilots Association (AOPA). AOPA represents more than 260,000 pilot members who fly general aviation aircraft for business and pleasure. We are the world's largest group of individuals affected by the FAA programs being considered at these hearings.

AOPA welcomes the opportunity to appear before you today to comment on the early stages of the FAA's National Airspace System Plan and the effect that decisions made now and actions taken by the FAA in the next few years will have on general aviation and the latter phases of the Plan.

AOPA appeared before this Committee on May 24 and spoke in great detail of the FAA System Plan and its effect on general aviation. We will not reiterate comments made at that time, but reaffirm that they continue to hold true. It may be helpful, however, to summarize our position for the record. The National Airspace System Plan has some 97 programs listed. In the following list, we have consolidated many of these into single headings for convenience.

EN ROUTE

Support: Central flow control. 9020 computer replacement. Sector suite concept. Automated en route ATC (AERA). Center consolidation. Long-range transition to Mode S.

Oppose: Forced early implementation of Mode S above 12,500 feet. Forced implementation of Mode S above 6,000 feet MSL.

TERMINAL

Support: Enhance ARTS II and III. Enhance TRACON Brites. Terminal hub consolidation. Terminal/center integration. Closure low activity towers. Plan says 30, we recommend 60.

Oppose: Automated airport services. Wake vortex detectors. We say eliminate wing tip vortices at source.

FLIGHT SERVICES

Support: FSS automation and consolidation. Voice response. Automated weather observations. Remote weather radar.

Oppose: Wind shear system.

GROUND-TO-AIR-SYSTEMS

Support: Replace tube type equipment. TWEB on NDB (not in Plan). Gradual implementation of Mode S.

Oppose: TWEB and weather data link on VOR in the short-term. MLS/PDME. Plan has too much, too soon, forcing the issue. ICAO protection date may be extended.

OTHER

Support: 3,500 foot runways.

Oppose: Use of enplanements to justify airside expenditures.

AOPA is on record as opposing the funding of this program as a totality for a number of reasons. First, the program is incorrectly termed "a systems approach." Secondly, the equipment plan dictates airborne equipment requirements without industry participation or comment. And third, the Plan contains several "stand-alone" programs which should require individual review and approval of disapproval. We would like to amplify on each of these items.

To call thr FAA Plan a "system plan" is a work of literary license. There was no industry participation—regardless of what FAA has represented—in the development of this "system" plan. Perhaps the FAA representation was referring to industry participation in deliberations in the program development of certain issues or items addressed in the NAS Plan. For example, the FAA has made the Flight Service Station (FSS) Modernization Program a subsystem of the NAS Plan. The aviation community has certainly been involved for decades in this long overdue improvement program. We have also been involved in commenting on FAA past plans to implement future Microwave Landing Systems (mls). We have been opposed to the MLS Program. To suggest that industry has participated in the entire system

plan is an exaggeration of the truth. We have been involved—as a proponent and opponent—on different pieces of the program. We were never consulted as these individual items were being developed into a "system" package.

Since many of the elements of the FAA program overlap and affect other elements, some of AOPA's prior positions have taken on a new light. For example, in some cases flight strip printers and ILS's will be in use only two to five years before being replaced with fancier equipment under the same Plan. A second example, as mentioned in our testimony of May 24, is the Plan proposal to implement 25 kHz VHF communication channels by 1990 because of the "demand" for more channels. This appears inconsistent with portions of the Plan which indicate a decrease in demand made possible by reduction in a number of Air Traffic Control Towers, consolidation terminal and en route facilities, and the reduction in the number of sectors.

The second fallacy of the FAA Plan is that it does not contain FAA dictates of what airborne equipment will be required in the future. It is technically correct that no specific requirements are in the Plan. However, the Plan suggests that to continue operating in the system aircraft will be required to eventually have an MLS receiver, mode S transponder, and TCAS equipment.

In response to direct questions on whether the equipment will be required as a "price of admission" in certain airspace, the FAA states that those decisions will be made in the process of their National Airspace Review—a 42-month government/industry look at the regulations, procedures and airspace designations of the current environment. Does the FAA expect us to believe that they will listen to the users during the National Airspace Review and that the ATC Plan does not dictate future airborne equipment requirements, when the Plan was released as a completed document in January and we are currently only in the third week of the 42-month-long National Airspace Review?

AOPA has determined that a best guess at the FAA's "suggested" new airborne equipment for continued operation in the system will cost $10,000 per airplane in 1982 dollars. Considering the FAA estimates that 200,000 aircraft will desire entry into the system by the year 2000, this would be a direct cost to the users of not less that $2 billion and possibly up to $3 billion depending on how many aircraft have or are required to have dual sets of equipment. These are direct costs added to what owners are being asked to pay in additional taxes levied to support the ground portions of the NAS Plan.

AOPA's final contention is that the Plan is a collection of stand-alone programs that deserve the review and individual approval or disapproval of the users and funding authority from Congress. In some cases certain programs within the NAS Plan have already been reviewed by numerous Congressional committees. The modernization of the Flight Service Station network is an excellent example. In some cases, such as weather dissemination programs, being included in the NAS Plan has only meant additional delays. It will be 1990 before we will see any improvements in the weather dissemination programs since they will now have to await other automation and communication improvement "subsets."

We believe the Congress should work to insure that technological and funding flexibility be added to the Plan. There is not expected to be much growth in the transportation function of the Federal budget. Since the relative timing of the development of parts of the Plan seems to be such an integral element of the Plan, we are concerned about the impact of the inevitable "stretch out" of the program.

In any event, progress needs to be monitored closely and options should not be foreclosed. Budgetary dictates also require that less costly options be pursued to insure that safety and capacity gains be achieved in the face of funding limitations.

Senator KASSEBAUM. Thank you, Mr. Warner. I try to rise above parochial interests as much as possible, but I would like to say I have not only heard from a great number of your constituents, but my constituents as well.

Mr. Snodgrass.

Mr. SNODGRASS. Thank you, Madam Chairman. Thank you for giving me the opportunity to represent the views of the manufacturing industry with regard to the proposed national airspace system.

We endorse the objectives of the FAA's national airspace system plan and urge that implementation begin at the earliest possible date. This is, for a change, a systems approach based upon integrat-

ed planning, and it includes the scheduling of specific elements from the research and development stage to the implementation of facilities and equipment.

The new system will require a highly skilled, dedicated management to achieve its stated goal. The AIA believes that while there are technical alternatives to be considered and some further details to be worked out, it is important for the Congress to make a commitment to move ahead with this national airspace system plan.

We have some criticism of elements of the plan. We like to think they are constructive, but as a whole, we want to see the plan go forward. We think there is a shortcoming in the description of how the system works or the potential benefits in the plan as presented in the Brown Book. It is certainly designed to reduce FAA costs, improve efficiency and provide higher levels of safety and relieve congestion.

The AIA would also like to see emphasis on improved efficiency of flight operations which are readily available under the framework of this plan. A new computer is needed to implement automation programs for more efficient flight coordination. The mode S data link capability will allow new functions as more data can be interchanged between the air traffic control system and the airplane, and the microwave landing system will provide improved all-weather landing capabilities.

The potential contribution of advanced avionics—such as flight management systems on board the airplane—for optimizing flight profiles and increasing airport capacity has not been treated as part of the system for air traffic control. In this respect, the NAS plan appears less than adequately responsive to our concept of user needs.

The use of four-dimensional navigation guidance in the current ATC system can provide some fuel savings, but the major fuel savings and increased airport capacity benefits depend upon the implementation of a more sophisticated time-based system which allows the use of 4-D navigation and guidance from en route to runway.

With the additional computing capability, fuel optimal delay absorption procedures can also be formulated, and detailed clearances transmitted to the so-called 4-D equipped aircraft for precise execution. Now, we have some of these 4-D aircraft in operation today. These efforts, which provide near-term improvements in airport capacity delay reduction and fuel-efficient flights should be pursued vigorously without being keyed to computer replacement. A system to provide relief from the wake vortices constraints in air traffic control is also vitally needed.

We feel that two areas warrant particularly close monitoring. These are the software developments, and certain airborne elements of the system. We feel development of a host replacement computer which uses software from the 9020 programs with minimal modifications will require very flexible and adaptable management. The lack of top down structure design in the present computer software, since it is evolutionary in nature, will present a complex rehosting software task with many unknowns.

Real-time application programs, such as the software programs, are not as portable as other general purpose or batch software, which these people are more familiar with in computer activities.

Attempting to further adapt our present programs which were designed 20 years ago will be a major challenge in the hosting procedure.

The development of the complex control logic and the automated en route air traffic control system will involve substantial technical risks because you are attempting to emulate the controller's separation planning process and replace it with a computer process.

As far as the airborne elements are concerned, many of the planned subsystems such as TCAS, MLS and mode S data link are crucial to the success of the system, yet the criteria for acceptable installation of the airborne segments have not been established or published. We feel that this must be attacked with considerable effort before getting too far into the program.

The technology options which should be pursued in parallel with the published plan, as we pointed out, include the utilization of airborne data processing capability and the development of automation programs such as integrated flow management and automated en route ATC.

Recognition should be given to the fact that the flight management computer systems are basic to new technology aircraft. Other similar systems are being considered for older model aircraft. Our concern is with an apparent lack of commitment to involve the so-called "smart airplane" in the FAA's automation plan.

The ATC system should exploit onboard capabilities to provide operational benefits where the traffic allows. This is, of course, in terms of transport aircraft, and when we say "where the traffic allows," that would include those areas which are largely populated only by transport aircraft. There are a number of such systems.

That is a summary of our position which has been provided you for the record in long form. I would be happy to answer any questions.

[The statement follows:]

STATEMENT OF JOSEPH C. SNODGRASS, JR., DIRECTOR, AVIATION PROGRAMS, AEROSPACE INDUSTRIES ASSOCIATION OF AMERICA, INC.

Madam Chairman and Members of the Subcommittee, I am Joseph C. Snodgrass, Jr., Director of Aviation Programs, speaking on behalf of the Aerospace Industries Association of America, Inc. (AIA), representing the nation's major manufacturers of aircraft, aircraft engines and related components and equipment. AIA endorses the objectives of the FAA's National Airspace System Plan (NASP) and urges that implementation begin at the earliest possible date. The FAA Plan represents an impressive planning effort and, as such, answers many criticisms industry has voiced in the past. It is a systems approach, based on integrated planning, and includes the scheduling of specific elements from the research and development (R&D) stage through implementation of facilities and equipment (F&E). The new system is comprehensive, highly automated, and will require a highly skilled, dedicated management to achieve its stated goals.

The major thrust of the plan, which is to change the existing labor intensive (controllers and maintenance personnel) system to a more automated system with remote maintenance monitoring, should provide marked economic benefits. The AIA recognizes that the National Airspace Review (NAR) and the FAA research, development and facilities program, supplemented by the studies of the AOCI-chaired Airport Congestion Task Force, will provide additional understanding of how the facilities described in the NASP will be utilized. As presently written, the Plan primarily describes an ATC system framework (hardware, software, functional capabilities), but does not explain how the system will operate or the potential benefits. A comprehensive evaluation will require airspace, operational and research plans, as well as a benefits analysis. The Plan is designed to reduce FAA costs while assur-

ing safety. While AIA is also committed to maintaining the highest possible level of system safety, we also seek efficiency of flight operations, and in that respect, many improvements which should lead to safe and efficient flight operations are included in the Plan. The new computer is needed to implement automation programs for more efficient flight coordination, the Mode-S data link capability will allow new functions as more data can be interchanged between ATC and the airplane, and the Microwave Landing System (MLS) will provide improved all-weather landing capabilities as well as a reduction in the low altitude flight time involved during the approach to the airport. This, in turn, will result in fuel savings and reduced noise levels.

The potential contributions of advanced avionics, such as flight management systems, for optimizing flight profiles and increasing airport capacity are not treated as part of the system for traffic control. In this respect the NAS Plan appears less than adequately responsive to the AIA concept of user needs. Although the schedule as a baseline seems reasonable, some observers believe that parts of the FAA forecasts for civil aviation growth upon which the new FAA Plan is based are too high. However, we believe that lower growth forecasts should not affect the basic plan, its objectives or implementation timetable.

The replacement of the 9020 en route computer is the key feature of the NASP that will affect all aspects of air transportation. The improvement in computer capacity and reliability will provide more cost effective operation of the ATC system, and increased safety and operating efficiency for the airspace user. It has been clear for some time that a new en route computer system was needed if the benefits of ATC automation were to be achieved. For instance, the use of 4-D (four-dimensional) navigation guidance in the current ATC system can provide some fuel savings, but the major portion of the fuel savings and increased airport capacity benefits depend upon implementation of a more sophisticated time-based system which allows the use of 4-D navigation/guidance from en route to runway. The automated en route metering program, which is the first step in automated time-based control, is an extension of the current NAS software, but expectation of any further growth capability in the system is low due to the lack of available computer capability. The implementation of a time-based integrated flow management system which fully exploits the capabilities of modern aircraft and flight management systems and uses airborne (4-D) navigation/guidance to provide fuel-efficient control of traffic requires the modernization of the FAA's ATC computers. With additional computing capability, fuel optimal delay absorption procedures can also be formulated, and detailed clearances transmitted to 4-D equipped aircraft for precise execution.

Those efforts which may provide near-term improvements in airport capacity delay reduction and fuel-efficient flight should be pursued vigorously without being keyed to computer replacement. A system to provide relief from the wake vortices constraints is also vitally needed.

Since most of the program elements are based on demonstrated technology, the overall level of technological risk is low. However, two areas warrant close monitoring—software and airborne elements. Possibly the greatest uncertainty from the standpoint of cost overruns and schedule slides is the estensive software development program. The development of a host (replacement) computer which uses existing software from the 9020 programs with "minimal modifications" will require flexible and adaptable management. In this regard, three areas should be given particular attention:

(1) The need for universal programs to satisfy each air route traffic control center's (ARTCC) unique requirements, the changes dictated by different (new) computer hardware configurations, and the lack ot top-down structured design in the present computer software (due to its evolutionary development) all add up to an enormous and complex re-hosting software task with many unknowns. Additionally, the real-time applications nature of the 9020 software may have dictated design features which will be incompatible or undersirable with another real-time system. This is a consequence of real-time applications programs that are not as "portable" as general purpose, batch software.

(2) Significant progress has been made in the development of software whose design will facilitate testing, maintenance and reliability. Disciplines involving structured analysis, structured design and the use of high-order, structured languages have all provided significant reductions in the life cycle costs of large, complex software system development. Attempting to further "adapt" programs designed 20 years ago will be a major challenge.

(3) The development of complex control logic in AERA-type algorithms, which attempt to emulate the controller's separation planning process, may involve substantial technical risk. Historically, the development of artificial intelligence programs

(pattern recognition, for example) have taken longer and been more expensive to develop than expected. Also, safety-related issues of software design reliability may be difficult and expensive to demonstrate.

Another area that requires further attention is the airborne element of many of the planned subsystems (e.g., TCAS, MLS, Mode-S data link). The airborne elements are crucial to the success of those subsystems, yet the criteria for acceptable installation of the airborne segments have not been established or published. Although effort is under way and will probably be described in forthcoming planning documents, definitive standards will require supporting analytical and test data which are not yet available.

The major thrust of the plan—to change the existing labor intensive system to a more automated system—is highly commendable. However, technology options which should be pursued in parallel with the published plan should include utilization of airborne data processing capability in the development of automation programs such as integrated flow management and automated en route ATC (AERA). Recognition should be given to the fact that the Flight Management Computer Systems (FMCS) are basic to new technology aircraft. Other similar systems are being committed to or being considered for older model aircraft. Our concern is with an apparent lack of commitment to involve the "smart airplane" in the FAA's automation plan. A system design objective to minimize avionics requirements is questionable. The pay back period of Flight Management Systems, involving fuel and operating cost savings, is on the order of a few years. The ATC system should exploit these on-board capabilities by developing operating procedures which will (in an evolutionary process) provide operational benefits where traffic allows. This is particularly applicable to air transport operations in that portion of the airspace where they are nearly the sole user. The incorporation of 4-D RNAV (area navigation) to provide more fuel-efficient higher-capacity control of air transport traffic is one example. While the 4-D RNAV equipment does not necessarily have to be a requirement, the ATC system should be designed to obtain the full measure of user and ATC system performance improvements which 4-D RNAV can provide.

In summary, Madam Chairman, AIA believes that while there are technical alternatives to be considered, and further details to be worked out, it is most important for Congress to make the commitment to move ahead with the National Airspace System Plan.

Senator KASSEBAUM. Thank you very much.

I appreciate the testimony of all three of you.

Mr. Warner, I would like to direct the majority of my questions to you because I think you have had the greatest criticism of the proposal and the funding, and I think I would also suggest some misunderstanding, perhaps, on the part of the membership of AOPA about what exactly has been contemplated.

One of your criticisms is in the national airspace review program, and I would only suggest to you that perhaps you are prejudging that review. Are you yourself serving as a member of that or is AOPA represented?

Mr. WARNER. Yes, ma'am. I am more comfortable now the yellow light is off. I thought perhaps I should proceed with caution.

I am serving on some of the task groups. The national airspace review is divided into, I believe, 16 groups that will hold 66 separate meetings over the course of the next 36 months. Our staff is participating on at least half of those, all that we believe affect our flying currently and in the future

We would like not to prejudge what is going to take place in the national airspace review, but when NAR was announced in the middle of last year, we and many of the other industry representatives pointed out to the FAA that many of the items that had been put into the national airspace review for consideration—examples, military training routes and their activity and their effect on civil aviation, terminal control programs, the charting of aeronautical information, the procedures in which we deal with the construction

of tall towers that affect navigable airspace—all of these subjects have been dealt with for a number of years. Indeed, there were regulatory review processes that took place in the mid and late 1970's in which all of our organizations participated, talking about the same subjects.

So we indicated last summer our concern that we were merely the same people going to go back in the room again to talk about the same subjects. Many compromises had been made in years past on the subjects. Positions of different segments of the aviation industry are well known and we were concerned as to what exactly the review was to accomplish.

We were told, that first it was brought under an umbrella so it would have direction within the highest level in FAA; instead of working with some of the Indians at FAA, indeed the commitment of the entire Administration would be behind conclusions coming out of the review.

The statement was made by the Administrator and the Deputy Administrator at the time, and we took them at their word. We told them we would participate. We and others in the industry were skeptical about participating at all because we were concerned that we were only going to plow through the same old ground.

The indications as a result of my personally sitting in on the committee a number of days in the last 2½ weeks and having reports back from individuals who report directly to me who have been there for 2½ weeks from 9 to 4 every day is that we are indeed replowing the same old ground, and they have concern that the FAA has made up its mind what it wants to do in these different areas and are merely using the national airspace review as a place where in the end they can have the conclusion that the entire aviation industry participated and here are the conclusions.

Senator KASSEBAUM. It seems to me if you are plowing over the same old ground, you really could only be doing it to a limited extent because you have before you a very different proposal and an integrated concept for the future of aviation, and I should think that what you would be reacting to would, I think, take you away from the same old plowed ground.

Mr. WARNER. Thank you very much for that question. There is apparently some misunderstanding within the working groups as to whether we are to consider the assumptions that the Brown Book brings to us. Some individuals who are in the working groups are saying we are only to address the existing system, problems within the existing system and how to improve them. In other words, terminal control areas will stay in place as they are today. That is what the FAA decided on as a means of controlling traffic in high density areas 10 or 15 years ago. We are only there to improve upon that. That is one school of thought. And indeed, the words in the charter of the national airspace review support that.

The second school of thought, which comes from words we have heard from the Administrator in public forums and in congressional testimony, is that we are to consider the assumptions that we will have at certain years in the future. In other words, we are to make recommendations as to what the rules, regulations, and pro-

cedures should be at that time, assuming TCAS, assuming mode S, assuming MLS.

Those are the two different schools of thought, and in the first 2½ weeks in the working level there are still two schools of thought. It has not been resolved whether we are addressing the present or something in the future.

Senator KASSEBAUM. I am sorry Mr. Helms is not here to answer. I would only say I feel relatively sure from what I have heard him say and express that it is the latter concept, that this indeed is a review board to be looking to the future, and its input will be very important on some of the future concepts which involve far more the users at that level.

Mr. WARNER. We would hope that the latter is the case, because positions on many of these subjects are well entrenched over years of hard work, disagreement or compromise, and we would like to be spending our time talking about the future in the national airspace review. We think it would be much more fruitful. It is very difficult, realizing there is some opposition to certain programs within the plan, but we think we should be spending our time there also.

Senator KASSEBAUM. It is always hard to move people from entrenched points of view.

Mr. WARNER. Yes, ma'am, it certainly is.

Senator KASSEBAUM. You mentioned the VFR and the IFR, and the majority of general aviation users do fly VFR. Coming into National, and I am not a pilot, but I would only suggest if I were coming into National, I would certainly want to be on IFR. Is that not something you would agree, as a pilot you would want to use IFR coming into National?

Mr. WARNER. No; I would disagree, the reason being that as a result of my flight, which was 35 miles from the airport at Frederick, Md., to Washington National, I would have flown approximately two to three times as far, expended two to three times as much gas and polluted two or three times as much as I did by flying VFR. There was no need for there to be any control of my flight until we got within a certain radius of Washington National.

Senator KASSEBAUM. There wasn't, is that correct?

Mr. WARNER. That is correct. And the reason I would not want to fly IFR to Washington National today is because the routing I would have gotten by an inflexible air traffic control system, something we are here discussing the improvement of, would have resulted in me flying three times the distance to get from Frederick, Md., to Washington National Airport, and there was no need for that.

AOPA realizes, responsibly so, that there is a need for control around certain major airports. The locations where there are currently TCA's are probably those locations. The difference of opinion between AOPA and perhaps the airlines and certainly the FAA comes with how many locations are there and how much airspace should be dedicated to having more control than the area in which there is not the need for control.

Senator KASSEBAUM. I think you heard Mr. Helms testify that indeed this will be something which will be subject to input in the

national airspace system's review, and that there has not been a mandating of this equipment as has been assumed by some.

Mr. WARNER. We are encouraged by the statement he made this morning, but that decision will be made later and it will be made on the basis of a need for the equipment based upon density. General aviation, I think, perhaps gets a bum rap when it comes to the requirement of equipment and our attitude on it. As was mentioned, 70 to 75 percent of the aircraft in the United States are currently equipped with transponders. Only about half of those are mode C or altitude reporting transponders, but the fact is virtually all of the aircraft flown in the instrument system that are flown on instrument flight plans have that equipment.

That was not a result of regulation. There is no regulation that says you have to have a transponder today to fly IFR, but the facts are the majority, nearly 100 percent of those aircraft that fly IFR, even if they are 17- or 20-year-old aircraft, have been retrofitted with that equipment, because the pilot recognizes the flexibility and advantage that equipment gives him.

We would like to see that be the way of equipment implementation in the future also.

Senator KASSEBAUM. AOPA has suggested in its testimony and in its letters to members that Congress is giving the FAA a free hand with the program. Actually, we are now authorizing funds for only 23 percent of the plan and yearly appropriations are still required, which I think you understand, although you mentioned the funding approval by Congress as one of your concerns.

Don't you think this will give Congress sufficient control over the course of the plan and assure that the money will be wisely spent? Again, I don't think we can prejudge when we do, as a matter of fact, have that oversight responsibility and that funding control.

Mr. WARNER. I would agree that we should not prejudge. However, I would hope that the program and approval from Congress would be structured in a way that we the users and we the aviation industry will have an opportunity to come back in subsequent years and say here is what the plan said in 1982 as to where we should be in 1983, 1984 or 1985, and here is where we are not, and here are the reasons why. They may be good, they may be bad. It is that type of flexibility we are looking for.

Senator KASSEBAUM. I am sure that will be there. I think all of us interested in aviation, and certainly those of us on the Aviation Subcommittee and on the Budget Committee, are going to be keenly aware of the need to do just that. Those of us who are not only involved in the appropriations and funding process but on the legislative process for aviation would not have necessarily chosen the present ADAP proposal as a first choice, but it was very necessary, I think we all agree, not only on the need to go along with a NAS plan, but certainly for ADAP, and in order to do so, there are certain balances that have to be struck. But that does not mean that we are abdicating any sense of responsibility in following through to see that indeed it functions as it should, and I think those safeguards are there.

I would like to go back to the mode S data link a moment. I am not sure myself on all of the ins and outs of the mode S data link. I am almost beginning to think one should be a pilot to chair this

committee. But is there any question in your mind over whether the mode S data link is a desirable enhancement, at least for commercial aircraft, and that it should be implemented quickly?

Mr. WARNER. No. There is no doubt in my mind that mode S is an enhancement in the current system. By another name, DABS, we supported the program or the development of that program in the past. We recognize that there are some advantages in mode S and data link to general aviation that should be made available in the marketplace for an individual to make a decision as to whether they want that equipment or not.

Our other concern is those people who have already invested in the equipment, the current transponder equipment, be given an appropriate amount of transition time to amortize the money they have spent on their equipment. We have no problem with transition to mode S in the long run. Indeed, it will provide us some very valuable options of data link with weather information from the ground to the aircraft.

Senator KASSEBAUM. Dr. Goldmuntz in his written testimony suggests the increased flexibility created by the new system will benefit general aviation users operating in the vicinity of major terminal areas to the same extent as commercial users, and that there will be an across-the-board fuel savings of 6 percent of current usage. He contends that this will save general aviation users about $170 billion a year.

Has AOPA made any specific cost/benefit studies of the plan, and if so, how do your results compare with those put forward by Dr. Goldmuntz?

Mr. WARNER. We have not gone into that much analysis as to what fuel savings would be available. We are very anxious to see Mr. Goldmuntz' analysis because, frankly, from a more general sense, I wouldn't be able to support that statement that general aviation will benefit as much from the fuel savings and flexibility standpoint in the major terminal areas as the air carriers will.

Again, this takes us back to the national airspace review because most of the inflexibility there for increased direct costs in the operation of a general aviation aircraft in the major terminal areas today are the result of the rules, regulations and procedures in effect. As an example, after I came into contact with the terminal area today at Washington National, I then flew a route about four to five times as long as necessary to get to the airport. Four to five times that distance. That is not a result of equipment. Is is procedures.

Equipment that is in the plan has an effect on that, but that is not the only problem. The procedures, the separation standards used to separate my aircraft from other aircraft, the routes determined by the FAA to be flown, those will be discussed in the national airspace review. And they have a substantial effect on how flexible flying can be in those areas and what cost savings the program would bring.

In conclusion, I would have difficulty endorsing that statement without seeing a lot of the detail as to how just equipment on the ground, which is all the Brown Book is, can make that big a difference to general aviation.

Senator KASSEBAUM. Thank you.

Mr. Ralph, you mentioned the management question and the concerns you had. Given the fact that I did ask Mr. Helms a question about that and the consistency and continuity, and you did, I believe, say you felt that some of those questions had been addressed in his testimony.

Mr. RALPH. Yes. Some of the information given this morning is new information, to us, at least. We are pleased to hear these adaptations and modifications and initiatives being taken. I wanted to highlight two challenges that seemed to me to have gotten lost in the hardware argument.

Those two challenges were, first, a management challenge, which I believe is now getting the kind of focus and attention that will be helpful to the FAA and the user community in coming up with managerial schemes, managerial organizations and procedures that will be beneficial.

The other item was software, the software challenge. That gets to be a little esoteric, but I think one of the advantages of the FAA approach to the general modernization as related to the computers, and this is the core of the modernization effort, I believe, is that they have taken a very conservative approach with hardware, primarily concerned about reliability, maintainability and productivity, so that they will be able to give appropriate managerial attention to the software management.

That will be an extremely challenging problem for them. I think it is a challenge they can overcome, but clearly in the modernization effort the number one challenge will be managerial, not hardware, and the No. 2 challenge will be the software aspects of it. Again, it is not hardware.

Senator KASSEBAUM. Thank you Mr. Snodgrass. Do you have any comments on anything raised?

Mr. SNODGRASS. No. I would certainly agree with Mr. Ralph on the fact that the hardware approach is conservative, except for some minor details I mentioned. But these are small elements. The major elements are conservative from a hardware standpoint, and it is indeed the managerial aspect and the software application adaptation which will lead to trouble if there is trouble.

I think Mr. Helms' announcement this morning of an outside overseer for the program was encouraging. I think that may help provide the continuity that our political process tends to break up from year to year.

Senator KASSEBAUM. I would like to ask either of you gentlemen if you would care to respond to AOPA's criticism of the national review program, the airspace review board?

Mr. RALPH. Well, we are participating in the national airspace review also, and I think there is a large degree of agreement on some of the comments Mr. Warner has made. There is apparently a misunderstanding or a misdirection on someone's part. Whether it is at the second and third echelon in FAA that is staffing the national airspace review, or it may be on our part, I don't know.

But we certainly went into the national airspace review with an opinion that the purpose was to try and look at the airspace, its organization, and its procedures, and to come up with new ideas, new concepts, suggestions, recommendations, if you will, that will make the airspace organization and the airspace procedures com-

patible with the new things that were going to be done in the national airspace system plan.

We saw these as mutually supportive operations. And our participation so far has indicated that many of the people representing the FAA on these panels believe that we are only refining current procedures and organization of the airspace. Now, perhaps there is the problem that these folks want to know how to get from here to some future time.

But I must say that right now there does appear to be a modest discontinuity between the assumptions we were operating on when we went into the national airspace review versus what we are experiencing now. I hope that gets worked out.

I really must agree that I do not see much utility in rehashing the last 10, 15, or 20 years of all of our airspace hassles. But I do see a great utility in trying to get companion ideas for organizing the airspace for new procedures and concepts that would be companions to the new hardware modernization the FAA is undertaking.

Senator KASSEBAUM. Thank you.

Is there anyone here from the FAA who would care to comment on this particular point?

[No response.]

Senator KASSEBAUM. If not, I am sure the word will go back. I think it is a very valuable observation. Thank you very much.

Mr. RALPH. Thank you.

Senator KASSEBAUM. The next panel, please: Dr. Goldmuntz, Mr. Thomas, and Mr. Davis.

It is a pleasure to welcome the three of you: Dr. Goldmuntz, president, economics and science planning; Mr. Thomas, a consultant to General Aviation; and Mr. Davis, who is here to testify this morning. I understand you have a time problem. We will move this panel along. It does seem to take some time as we get into these issues. On the other hand, I think an explanation is very important.

Mr. Davis, would you care to start off the testimony?

STATEMENTS OF HARRY DAVIS; DR. LARRY GOLDMUNTZ, PRESIDENT, ECONOMICS AND SCIENCE PLANNING, WASHINGTON, D.C.; AND DAVID THOMAS, CONSULTANT, GENERAL AVIATION MANUFACTURERS ASSOCIATION

Mr. DAVIS. Thank you. I should introduce myself. I brought my biography to you. I prefer not to read it. I have had some background in large systems, largely with defense.

You have previously heard of the reasons for the proposed national airspace plan. Rather than go over my perceptions of the needs I would like to review some of the viewpoints expressed in the OTA review, whose report I read. I would also like to make some pertinent comments. I hope they are pertinent.

First, on page 1—and I know it is bad to take things out of context, but I picked these particular quotes for some points I want to make later. On page 1 of the report I have, which I can leave if it differs from the one you have, is this statement:

Viewed on this high level as a statement of policies, goals and directions, the NAS plan is to be commended as a significant and even bold step compared to past FAA efforts to chart the future evolution of the system.

I would like to make this comment. I don't know if everyone recognizes it, we have a unique Administrator in FAA. Mr. Helms is one of the best men we have, and I think it is an opportunity to get some things done. And I would certainly say that it is important that we try to get it done during his tenure, because he will be leaving at the end of this administration. He is a dynamic, forceful leader. I think it is a golden opportunity to get this program started while he is still here. Obviously, I am an admirer of him and I need say no more.

Another quote from page 1 is: "The capacity of the airports would limit systems and most of the proposed improvements will be en route and not in the terminal area." I liken that to the fallen arch syndrome: Don't treat the dental cavities until you treat the fallen arches.

There is no doubt that we have to take care of airports, but we also have to take care of en route. And there is nothing to prevent us from doing both.

On page 2 it says: "The plan is comprehensive, technologically feasible, consistent with the goals of increasing safety and future growth." I agree with this. But later on there are statements in the OTA which are inconsistent with this point. It says that the growth forecasts are too high, that the FAA thinks the growth will not be as large as they plan, and therefore perhaps we do not have to rush this.

I think that this observation is practically irrelevant. We agree the upgrade is needed. We do not want to have 16,000 controllers. The plan should save, in my estimation, at least 4,000 controllers, which is a $400 million annual savings in controller costs. I have not seen that mentioned as an offsetting cost, but it is.

Another issue which no doubt you have heard about is the so-called clean sheet approach. Is that jargon or is that something you have heard?

Senator KASSEBAUM. I am not familiar with the clean sheet approach.

Mr. DAVIS. I am sorry. In this particular report some of the technologists who consulted for the OTA said, why do we not start with a clean sheet, why do we have to rehost, that is, take the present system, rehost it on new computers, when downstream we might have certain technological advantages and these hosts might become obsolete.

Senator KASSEBAUM. I just had not heard it phrased quite that way.

Mr. DAVIS. Well, in the report they mention it as the clean sheet approach.

There is always a danger in technologists worrying about 2 years from now there will be a better widget. There will be, but that does not mean that what you are doing will be obsolete at all. The host computers will be useful. I have checked around with people, people on the President's National Science Committee looking at that, and we agree there is no need to say to ourselves: "Hold off,

better technology is around the corner." The host computers will not be a throwaway.

I think the previous panel mentioned the software problems. They are real and I am not minimizing them. But we see no reason why you have to hold up because there might be some way of working with some other host computers or doing away with them altogether. I believe that is true, but the system will work, it will be safe, it will be evolutionary, and it is the right way to go.

They will have lots of problems, but that is nothing new. In other words, anyone who says, "Let's take a clean sheet," is advocating no hits, no runs, no errors.

I know of some examples, difficult to describe in an open hearing, where we tried to build huge systems without central host computers, and invariably we were forced to go back to the host computers, even though we had a distributed network.

On page 9 it says: "The plan is to be commended. It is a marked improvement over previous NAS planning." That is a repetition of page 1. "It is technologically feasible and desirable." And, it says, "There are alternatives that may be equally effective." It does not say "better," it says "equally effective." And the clean sheet approach essentially says we might be able to do it some other way with a newer technology.

One other point is we will worry about the fact that FAA must manage four contractors and, therefore, FAA should strengthen itself in the area of systems acquisition management. This is a pet peeve of mine, Madam Chairman. No one has demonstrated the assumption that we know how to manage.

If I look at how we are doing, say our productivity compared to the Japanese and Germans, I see ours is declining and theirs is growing. We have had a tremendous increase in growth of management. We are unique in all the nations of the world; we have a disease called "managementitis." And that disease is promulgated in that particular document and I take exception to it.

I am not sure we want to overmanage. In fact, every indication shows we are doing too much of [illegible]nd should do less.

I guess that means my time [illegible]

Senator KASSEBAUM. Yes; but do you have a few more things you would like to say?

Mr. DAVIS. I will wait until the questions and answers. Obviously, I think the program is sound, should proceed. The criticisms I have heard are trivial. Some are valid, but nothing to prevent it from taking advantage of the fact that we have a dynamic leader who can make the thing go now.

Senator KASSEBAUM. Thank you very much.

Dr. Goldmuntz.

Dr. GOLDMUNTZ. Madam Chairman, thank you very much for inviting me.

With your permission, I would like to submit my full testimony for the record and just abstract two portions of it.

Senator KASSEBAUM. Thank you. That will be done.

Dr. GOLDMUNTZ. Very briefly, I have worked on air traffic control for perhaps too long. When I first came to Washington I was executive secretary of the DOT Air Traffic Control Advisory Committee, which among other things recommended a change from the

forecast type of aircraft beacon to the speed-address beacon which is now being reflected in the mode S. But it took a long time to get there.

Senator KASSEBAUM. That is rather discouraging; is it not?

Dr. GOLDMUNTZ. Well, you just have to keep chipping away; do you not?

Senator KASSEBAUM. It leads to checks and balances, I suppose, which are worthwhile.

Dr. GOLDMUNTZ. I would like to make a critique of the OTA report in that dimension. I have worked subsequently on a variety of air traffic control committees, both independently for the FAA and as a matter of fact for the OTA. Some of my best friends work for the OTA, but I am afraid they have disappointed me with that report. I would like to tell you why and then talk very briefly about some of the cost benefits and how they are distributed among various segments of aviation.

First of all, OTA is correct, computers will be cheaper and better in a decade, but that is beside the point. The issue is, can computers be bought today off the shelf that will do the job for rehosting the current software and expanding current software to the kind of system we all want, which will be much more productive and safer. And the answer is a resounding, "Yes."

There is no reason to delay. If you do you will delay the much-needed productivity improvements, both for the Government and for the users of the system, for a decade. So I believe this point that the OTA makes is counterproductive.

The second point is also beside the point. They criticize FAA's forecast. If traffic does not grow, the proposed NAS plan proposal would have a benefit-cost ratio, as best I can estimate it, of 3 or 4 to 1, taking into account the benefits to the Government and the benefits to the users. If traffic grows the way the FAA forecasts, the benefit-to-cost ratio would increase to something like 5 or 6 to 1.

So what is the point of delay? If traffic doesn't grow the system will be excellent. If traffic grows the system will be even better.

OTA talks about satellites as if that is the most critical element in air traffic control technology. It is not. The most critical pacing item right now is to try to improve the ATC process itself, and that speaks to the need of a host computer and the changes in procedures that would allow us to make some of these trips into National Airport more efficiently than they are today because you have equipment to safely monitor and expedite traffic built into the computer process and built into the surveillance system.

Procedures and hardware go together, but you cannot adopt procedures unless you have the hardware that make them permissible. So the pacing technology is the ATC process itself, and that is what we should get on with right now and that is what the FAA is proposing.

OTA from time to time intimates that higher levels of automation would be unsafe. Quite the reverse is the case. Right now controllers make too many repetitive decisions. When people make repetitive decisions they get tired and make mistakes. And we have such mistakes in the system today. Repetitive functions can be performed by machines without error in most cases.

In a catastrophe, such as a center going down, a mild form of chaos results today. We have handbooks, we have procedures, and even some training. We do not have enough communication and computer hardware to mechanize catastrophe plans. In the new system you would be able to do that.

So I think OTA is wrong on four fundamental points. Therefore I think we should get on with the NAS plan as fast as we can.

I would now like to turn to payback periods for the investment in the NAS program for various types of aviation as best we can understand them at this point. If one has not perceived benefits, one does not know accurately what they will be and one can only estimate what they will be. Since manufacturers are not yet ready to provide quotes on avionics and ground system costs, one can only estimate such costs.

But one has to do that in order to make sure that the NAS proposal makes economic sense for all classes of aviation for the FAA. What I have tried to compute in table 1 of my testimony, is the payback periods to various classes of aviation, the payback period being the number of years of full benefit from the system that it takes to pay back the investment cost to the various classes of aviation.

The investment cost consists of the increased contribution to the aviation trust fund that the various components of aviation will make according to formulas you have been working on and their investment in the avionics needed in order to operate with the system using its fullest capability, and that is different for each class of aviation. So one has to list the difference in aviation costs and the differences in contribution to the aviation trust fund.

The benefits that come back to the user are the savings in fuel, the improvements in safety to the extent that one can quantify that, which is an extraordinarily difficult thing to do, the reduction in delays due to MLS and airport procedures, and the decrease in FAA operating and maintenance expenses as reflected in the contributions various classes of aviation must make to the aviation trust fund.

When one does all of that in a fair way, one ends up that the payback period for air carriers and commuters would be something like 4.7 years, for turbo-powered general aviation it would be 2.2 years, and for piston-powered aviation it would be 3 years.

Why is it that air carriers and commuters have a longer period to get back their investment? The reason is, they are making a very large contribution. Ninety-five percent of the total trust fund comes from air carriers and commuters. They get some very substantial benefits, but it takes them longer to get it back.

One can make a sensitivity analysis: What happens if the avionics costs are twice as great, what happens if only half of the projected fuel savings are achieved, what happens if there are no safety benefits that are measurable, what happens if instead of getting what has been taken as a discounted savings in operations and maintenance, I only 70 percent of what the FAA estimated as a savings, FAA is right and the full O&M savings are obtained?

Under the worst case there is only one payback period that is greater than 5 years, and that is for the air carriers and commut-

ers in case they only achieve half the projected fuel saving of 6 percent. In that case the pay back is 6.1 years.

So all sensitivity analyses for the various sectors of aviation tend to indicate that we should proceed with the FAA proposal to modernize the system.

Thank you very much.

[The statement follows:]

STATEMENT OF DR. LAWRENCE A GOLDMUNTZ, PRESIDENT, ECONOMICS AND SCIENCE PLANNING

Mr. Chairman and Members of the Committee, thank you for inviting me to appear before your committee. I should like to comment briefly on two aspect of the proposed National Airspace System Plan, (1) some criticisms of the plan by the Office of Technology Assessment and (2) and evaluation of the benefits received by various categories of aviation from implementation of the plan as compared with the investment they might make in avionics and the Aviation Trust Fund to implement the NAS plan.

It is perhaps relevant for the committee to know that I have had a number of years of experience working for DOT and FAA and, from time to time for the OTA on matters concerning air traffic control. I was Executive Secretary of the Air Traffic Control Advisory Committee that was organized by the first Secretary of Transportation, Alan Boyd, in 1968. That report recommended, among other things, the conversion of the air traffic control transponder to a discreet address Beacon System which is now embodied in the new NAS plan as the Mode S beacon. It also endorsed the prompt development and international acceptance of a microwave landing system to replace the present landing system. It also suggested higher levels of automation in air traffic control in order to improve productivity both for the operator of the system, FAA, and for the users of the system.

More recently, in March 1, 1979, I coordinated a year-long meeting of users and aviation industry representatives to provide the FAA with a set of new engineering and development initiatives. This was a review that consulted with some 260 representatives of the aviation industry to provide detailed guidelines to the FAA. These guidlines achieved the consensus of the great majority of the pilots, operators, controllers, technologists and airport operators who participated. In March of 1981, I submitted to the FAA a report called the AERA Concept. This was the cooperative result of a so-called Tiger Team consisting of two FAA employees and three non-FAA employees who were nonetheless experts in air traffic control. The purpose of this document was to provide a coherent framework in which a more highly automated and productive air traffic control concept could be embedded. The report described how the necessary reliability could be achieved; how pilots and controllers would work with the system; and finally how the users might benefit from the system. The unanimous opinion of the group preparing the AERA concept document was that it should be pursued by the FAA with dispatch because it would provide increased capacity, increased productivity for both users and the FAA and probably higher levels of safety than are currently achieved.

Turning to the OTA report, OTA asserts that computers will be better and cheaper in a decade than they are today. Quite right, but also quite beside the point. The point is that computers today are more than adequate for the improvement in automation that the FAA requires at the level of reliability that is needed. While the price for computers may well decrease in the next decade, this decrease in price will be overwhelmed by the loss of productivity if the FAA should not convert to a more productive system at the earliest possible moment.

OTA intimates that a system with higher levels of automation would be less safe than the current system. Quite the contrary is the appropriate conclusion. There are system errors today because controllers are asked to perform repetitive functions and to verbally check clearances with pilots. Automating such repetitive functions is less fatiguing and therefore a safer way of conducting business than under the present methodology. Furthermore, the higher levels of automation that the new host computer would permit are designed so that neither pilot nor controller are ever placed into a dangerous situation. If an entire center is destroyed, clearances for aircraft in the affected region, so-called back-up clearances, have already been prepared and stored in neighboring centers or at airport control towers in the region affected and are transmitted to aircraft to automatically assure them of safe passage out of the region in which air traffic control has failed. This is a much more methodical way of handling center outage than is currently the case. The more or-

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derly management of massive center failures is a direct result of the higher levels of automation and cmmunication capability in the improved system that the FAA proposes. Any delay in implementing such a system would diminish safety that could be available to the air traffic control system.

OTA's claim that FAA forecasts have been inaccurate and therefore the improvements in the air traffic control system that the National Air Space Plan contemplates will not be necessary, is unfortunately also faulty. Calculations have been made of the benefit cost ratio of the NAS plan if traffic grows as the FAA projects. Under these circumstances, the benefit cost ratio is of the order of five or six to one. Should traffic remain static, the benefit cost ratio would decrease from five or six to one to three to four to one. The reason for this is that the controller work force would still be more productive, delays would still be reduced, fuel economies will still be achieved by just the traffic that is now flying. In other words the value of the system will increase as traffic increases but the modifications proposed are highly beneficial even at current levels of traffic. So it is unnecessary for traffic to increase to make this system worthwhile.

Finally, OTA talks of the use of satellites in air traffic control, as if this is the key to the most needed technological advance in air traffic control; it is not. The most important technological advance in air traffic control is improvement in the control process itself so that less than optimum routing and altitudes and unnecessary delay can all be avoided while improving safety and all with higher contoller productivity. The first application of satellites would be for over ocean communication or navigation or surveillance. Such a system was attemptted by the FAA a number of years ago only to be rejected by the Congress and the users as being unnecessary in view of the capabilities that were already in hand. That same conclusion is true for a massive usage of satellite communications, navigation and surveillance within the continental United States. There are some advantages to such a system assuming one could separate the three functions of surveillance, communication and navigation which one must do for safety purposes. But the issue is whether the cost of such a system is worth the benefits if the FAA and the users are to pay for it. There has been no study that has been able to conclude that such massive usage of satellite technology has benefits that exceed its cost.

Turning now to the benefits of the proposed National Airspace system, it is useful to determine the value of the system to various sectors of aviation under a wide range of estimates of costs and benefits. Civilian aviation is considered to be composed of three major sectors, air carriers including commuters, turbo-powered and piston-powered general aviation. Since a major component of the benefit of the proposed NAS is fuel economy, categorizing civil aviation by type of fuel utilized, is appropriate. The payback period is used to measure the benefit to a particular class of aviation of the aviation trust fund and avionics investment required to implement and take advantage of the proposed NAS. Payback is defined as the number of years of full benefit needed to equal the investment, assuming 1982 dollars for both costs and benefits.

The FAA implementation of the proposed NAS system is assumed to cost eight billion dollars, and the decrease in FAA operations and maintenance costs with respect to what they would have been, absent this program, is assumed to be one billion dollars in 1992. This is 70 percent of FAA's estimate, a discount representing conservatism rather than lack of faith. Air carriers and communters, are assumed to pay 95 percent of the Aviation Trust Fund and turbo-powered general aviation 3.4 percent and piston powered 1.6 percent. The Aviation Trust Fund is assumed to pay 100 percent of the ADAP, F&E and R&D costs of the FAA—or the entire eight billion dollars required for implementation of the NAS plan. The trust fund is assumed to contribute 60 percent to the cost of O&M. Decreases in projected O&M expenses, therefore accrue to the benefit of air carriers and commuters to the extent of 57 percent, to turbo-powered general aviation to the extent of 2 percent and to piston-powered general aviation to the extent of 1 percent. Such a calculation implicitly assumes that inflation is equal for both benefits and costs and that the build-up of benefits matches the build-up of costs with perhaps a modest lag. This is certainly true for the user of the ATC system. It is less true for the FAA where benefits lag costs. The user will only buy additional avionics when the FAA has completed the needed ground environment and its benefits are perceived.

During periods of high interest rates, an acceptable payback period must obviously be shorter than during periods of low interest rate. A payback period must also be short compared to the useful life of the investment. Currently acceptable payback periods for large classes of investments are five years. This five-year period corresponds to the doubling time of an investment at 15 percent interest. All classes of aviation have a payback period of five years or less under most pessimistic as-

sumptions on NAS and avionics costs and the benefits to be derived from the implementation of the NAS Plan. This is shown in Table 1.

The calculation of benefits and costs of the proposed National Airspace System to various sectors of aviation indicates that the total NAS implementation and avionics investment cost of piston-engined general aviation is repaid within three years, the total investment cost of turbo-engined general aviation is repaid within 2½ years and the air carriers are repaid within five years. This disparity is due to the far greater investment in the NAS plan by air-carriers as compared to general aviation, under the sharing formula based on ticket, weigh bill and fuel taxes.

The prcision of such calculations is always open to question. After all, it is difficult to quantify benefits that are still to be perceived, and to estimate costs of equipment that are not yet in quantity production and in some cases not yet fully specified. Nevertheless, the payback conclusions are robust against a wide range of estimates of equipment cost and benefits.

TABLE 1.—PAYBACK PERIODS YEARS (ROUNDED-OFF)

	Air carriers and commuters	Turbo-powered general aviation	Piston-powered general aviation
Payback period	4.7	2.2	3.0
Payback period (double avionics cost)	5.0	3.1	5.3
Payback period (half projected fuel saving)	6.1	3.0	3.6
Payback period (no safety benefits)	4.9	2.7	4.3
Payback period (full O&M FAA cost reduction)	4.2	2.1	2.9

OVERVIEW OF BENEFITS OF NAS PROPOSAL

The most crucial element in the benefit/cost calculation is the estimate that both general aviation and air carriers will achieve a 6 percent saving in fuel due to the increased flexibility of the new air traffic control process. The 6 percent fuel-saving estimate is outlined in FAA-EM-82-11. Most of the fuel saving occurs within 150 miles of major terminal areas and below FL 310. Beyond 150 miles from major terminal areas and above FL 310, ATC has little difficulty providing fuel efficient profiles and routings. This means that GA aircraft operating in the vicinity of major terminal areas will receive at least as much benefit as air carriers from a more productive ATC process.

Using the FAA forecast for fuel usage in 1992, air-carriers are projected to use 11.5 billion gallons of jet fuel, turbo-powered general aviation is projected to use 1.8 billion gallons of jet fuel and piston-engined general aviation is forecast to use 0.810 billion gallons of aviation gas. The annual 6 percent saving—using 1992 projections—is shown in Table 2 for each class of aviation. The 1982 price of jet fuel ($1.00/gallon) and of aviation gas ($1.92/gallon) and general aviation jet fuel of $1.73/gallon is used.

Approximaterly 33 percent of the general aviation gasoline is assumed to be used for commuters and 38 percent of general aviation jet fuel is also assumed to be used for commuters. This is somewhat of an overstatement, but approximately correct.

The next most important element in the list of annual benefits is the reduction in O&M costs due to the implementation of the NAS program. FAA estimates this reduction to be approximately $1.4 billion in 1992. It is discounted to 70 percent of this value in Table 2 and pro-rated among components of aviation in accordance with their contributions to the Aviation Trust Fund.

Summarizing Table 2, the annual benefits for air carriers due mainly to improved fuel saving and reduced contributions to the Aviation Trust Fund and reduced delays due to MLS and airport improvements is estimated to be over 1.7 billion dollars by 1992. The annual benefits to piston-engine general aviation aircraft, due to fuel saving and improved safety due to TCAS and better weather information and advisories transmitted via the Mode S transponder would be approximately $120 million by 1992. If short runways are built at certain airports and MLS systems are installed to assure their independent operation and additional $60 million benefit could accrue to piston-powered general aviation. The accident rate of this class of general aviation is expected to improve more than any other category of aviation due to the improved accessibility to updated weather information provided by the modernized FSS and the Mode S data link which can also provide traffic advisories.

The annual benefits to turbo-engine general aviation in 1992 would be approximately $200 million due to reduced fuel consumption and reduced delys at hub airports due to MLS and airport improvements and increased safety due to better weather and traffic advisory information and TCAS.

An appendix to this testimony details the calculations leading to the quantification of these benefits.

AVIONICS COSTS TO USERS

In order to achieve the benefits, listed in Table 2 the 100,000 single engine general aviation aircraft that are estimated to equip themselves with Mode S transponders will have a one time expenditure of $300 million; the 35,000 twin and turbo-engine general aviation aircraft will spend approximately $350 million to equip themselves with Mode S, TCAS I and MLS in various proportions and the 5,000 commuter and air-carrier aircraft will spend approximately $500 million to become fully equipped with Mode S, TCAS 2 and full MLS. These implementation costs are shown in Table 3.

The assumed equippage levels in Table 3 are not inconsistent with present equippage rates. For example, air carriers have 100 percent dual equippage of Mode C transponders. Turbo-powered general aviation has 97 percent equippage, multi-engine piston-powered general aviation has 77 percent equippage and single-engine piston-powered general aviation has 21 percent equippage of Mode C transponder.

TABLE 2.—ANNUAL BENEFITS TO USERS MILLIONS OF DOLLARS

	Air carriers and commuters	Turbine-powered general aviation	Piston-powered general aviation
6 percent fuel saving (1992 forecasted fuel use) (1982 fuel prices):[1]			
Air carriers and commuters	790		
Turbine-powered general aviation		110	
Piston-powered general aviation			63
General aviation safety:			
Turbine-powered general aviation		[2] 40	
Piston-powered general aviation			[2] 60
Air carrier safety	[2] 65		
Delay reductions due to MLS:			
Air carrier and commuters	100		
Turbine-powered general aviation		15	
Potential increases in runway utilization due to MLS and operating procedures:			
Air carrier and commuters	200		
Turbine-powered general aviation		25	
Piston-powered general aviation [3]			60
Decreases in FAA operations and maintenance expense [4] (60 percent charged to aviation trust fund):			
Air carriers (95 percent)	570		
Turbine-powered general aviation (3.4 percent)		20	
Piston-powered general aviation (1.6 percent)			10

[1] Carrier jet fuel $1/gallon, general aviation av. gas $1.92 gallon, jet fuel $1.73/gallon.
[2] The cost of injuries and property damage has not been included, only the cost of fatalities (at $500,000) is included.
[3] Assumes new small runways are constructed at some major airports.
[4] Assumes $1 billion saving in O. & M. expenditures in 1992, (70 percent of FAA projections).

TABLE 3.—AIRCRAFT AVIONICS COSTS

Aircraft type	Number of aircraft equipped	Percent of aircraft equipped (percent)	Mode S	TCAS 1	TCAS 2	MLS	Total
Single engine GA	100,000	50	$3,000				300×10 [6]
Twin engine GA	12,500	50	3,000			$2,600	70×10 [6]
Twin engin GA	12,500	50		$3,800		2,600	80×10 [6]
Turbo GA	10,000	100		3,800		15,000	188×10 [6]

TABLE 3.—AIRCRAFT AVIONICS COSTS—Continued

Aircraft type	Number of aircraft equipped	Percent of aircraft equipped (percent)	Mode S	TCAS 1	TCAS 2	MLS	Total
Commuters and AC	5,000	100	17,000		$50,000	36,000	515×10^6

There are some questions as to costs of equipment. Generally, industry and the FAA seem to agree that a Mode S transponder basic cost is $1,400 plus $700 for the altitude encoder. The data entry and datalink display may cost an additional $500–$1,500 depending on its capability. Therefore, a point estimate of $3,000 was used for the basic Mode S transponder. The simplest version of TCAS I adds approximately $800 to the basic Mode S transponder to provide the receiver at 1090 megahertz and the data link display and readout. There are more elaborate versions of TCAS I that could for example detect and read out altitude and altitude rate, or could have an active mode—as in TCAS 2—but without the bearing capability, or could even have a simple bearing capability. These more elaborate versions would obviously cost more than that the simple TCAS I. Since it is not possible to determine now the mix of the various TCAS I that general aviation might eventually purchase, the cost of TCAS I for all general aviation, including the cost of the Mode S transponder, is assumed to be $3,800. The estimate of $50,000 for the most elaborate TCAS 2 seems agreeable to both FAA and manufacturers.

The same situation applies generally to the MLS. While an estimate of $2,600 is used for the simplest MLS, some manufacturers claim that installation costs of $500 would have to be added to such a low manufacturer's cost and that this low cost could not be achieved with the small production runs usually associated with the first introduction of a new product. Furthermore, if the full capability of the MLS were to be available in the cockpit, the cost might rise toward $10,000–$15,000 which is the estimate used for installations in the turbo powered general aviation. The costs are even higher for commercial aircraft, were redundancies will be required, particularly for low ceiling and visibility approaches. In this case, both FAA and manufacturers seem to agree to an estimate of $36,000 per aircraft installation.

SUMMARY OF PAY BACK TIMES FOR VARIOUS TYPES OF AVIATION

Comparing Table 3 and Table 2, and remembering that air carriers and commuters shall pay 95 percent of the eight billion needed to implement the proposed NAS and turbo-powered GA will pay approximately 3.4 percent and piston-powered GA will pay the remaining 1.6 percent one can derive Table 1. In particular one can see that the total investment cost of piston engined general aviation in avionics and the trust fund, is repaid within three years. Should the benefits due to short runway installations at major airports be neglected, the payback period for piston-powered general aviation would be slightly more than four years. If the safety goal described in the appendix of saving 200 general aviation lives per year is not achieved, the payback period is increased to slightly more than four years. The same general pattern applies to air-carriers and turbine-powered general aviation. Neglecting safety improvement goals for air-carriers and turbine-powered general aviation, the payback period for air-carriers is slightly less than five years, and for turbine-powered general aviation, it is less than three years. Including the safety benefits improves these payback periods only slightly. The reason for this is that safety, particularly for air-carriers is already excellent and even substantial percentage improvements do not compare on fiscal terms with the improvements in fuel efficiency due to optimum routing and altitude profiles and with delay reduction due to increased airport and runway capacity and with potentially reduced contributions to the aviation trust fund for operations and maintenance.

Should the cost of the avionics become twice as large as indicated in Table 3, then the payback period for piston-engined general aviation and air carriers and commuters would be five years and for turbine-powered general aviation it would be three years. One sensitivity issue relates to the estimated 6 percent improvement in fuel efficiency due to the availability of optimum routings and flight profiles. If this estimate turns out to be too optimistic and only a 3 percent improvement is in fact achieved, then the payback period for air carriers is six years, for turbine-powered general aviation three years, and for piston-powered general aviation less than four years. The payback period for air carriers and commuters is longer than that of gen-

eral aviation primarily because of the 95 percent contribution by the air carriers and commuters to the eight billion dollar cost of the NAS proposal.

These results are summarized in Table 1. The overwhelming conclusion is that the National Airspace Plan has excellent payback characteristics for all classes of aviation under a broad set of assumptions as to costs and benefits.

APPENDIX ON VARIOUS BENEFITS FROM THE NAS PROPOSAL DELAY REDUCTIONS AND INCREASES IN RUNWAY UTILIZATION DUE PRIMARILY TO MLS AND AIRPORT CAPACITY IMPROVEMENT PROGRAM

The implementation of MLS will reduce delays at major airports because of fewer disruptions due to weather minimums, fewer system outages, less airway constrictions and ground signal restrictions and reduced pathlengths as shown in Table A. Thcse are all improvements relative to the currently used ILS system. They would save air carriers and turbo-engined aircraft approximately $115 million per year in 1982 dollars when fully implemented. In Table 2 in the text, this savings is apportioned between these two classes of aviation in proportion to their fuel usage.

It is likely that new operational procedures, sometimes in conjuction with MLS, will improve runway utilization by permitting close spacing of independent IFR parallel runways (perhaps 3000ft) by allowing dependent IFR parallel runway operation below 3000ft, by providing operational solutions to wake vortex interactions such as "long" landings or multiple glide slopes, by IFR approaches to converging runways, by IFR operations on short GA runways on those airports large enough to support such additions and by facilitating computerized runway operation at O'Hare.

The annual benefits to be derived have been assigned by relative fuel usage between air carriers and turbo-engined general aviation, except for the short runway possibility. This benefit has been assigned entirely to piston-engined general aviation. These benefits assignments are shown in Table 2 on the basis of annual benefits in 1982 dollars calculated as 5 percent of the benefits to be achieved over a 20-year period after installation of MLS and the necessary runway and procedural modifications to take advantage of the new landing and guidance system.

TABLE A.—DELAY REDUCTIONS AT MAJOR AIRPORTS DUE TO IMPROVEMENTS IN TECHNOLOGY—DOLLAR BENEFITS TO AIR CARRIERS

[20-year totals in billions of 1982 dollars]

Microwave landing systems	Benefits	Case study locations
Reduced disruptions due to weather minima	0.9	Top 40.
Lower system outages	.1	Do.
Eliminate airway constrictions, ground signal restrictions	1.1	JFK (NYC area).
Reduced path lengths to terminal	.2	Top 40.
20-yr total [1]	2.3	
Concepts for increased runway utilization:		
Independent IFR parallels (to 3,000 ft)	1.0	JFK/DEN/DFW/MSP/MEM/PHL.
Dependent IFR parallels (below 3,000 ft)	.3	DEN.
Operational solutions to wake vortex	.3	DEN.
IFR approach to converging runways	2.0	DEN/DFW/IAH/MIA/ORD/STL/JFK.
Triple parallels	.3	ORD.
Short runways, dedicated to G.A.	1.2	ORD/ATL/PHL/DFW/JFK/DEN/STL.
Computerized runway management system	.6	ORD.
20-yr total [2]	5.7	

[1] Items 1–4 were estimated in FAA study of MLS benefits and costs compared to ILS; FAA No. EM–80–7, June 1980.

[2] Item 5—although some concepts are dependent on MLS technology, they were not quantified in the MLS study report cited above. These dollar estimates were obtained from "Briefing on Airport Capacity," presented by the Office of Systems Engineering Management on Mar. 18, 1982, to the Air Transport Association.

BENEFITS TO GENERAL AVIATION SAFETY

Should this program be successful, the safety record of some components of general aviation should be substantially improved. For example, under IMC conditions, fatality rates are 20 times worse than under VMC conditions for instrument-rated pilots whether in single or twin-engine aircraft. The IMC fatality rates are approximately two orders of magnitude greater than that which occurs on interstate highways. One objective of an ATC system should be to reduce general aviation IMC fatality rates to VMC levels. Furthermore, the fatal and serious accident rate for non-instrument-rated pilots who find themselves flying under instrument meteorological conditions inadvertently, is even greater than the rate for instrument-rated pilots.

Many of these proposed improvements to the National Airspace System should ameliorate this problem and improve general aviation safety. But quantitative estimates of the potential improvements are not feasible. However, if the fatal and serious accident rates to non-instrument-rated pilots flying inadvertently under IMC were reduced by ⅔—which would be still an order of magnitude greater than the rate for pilots who manage to stay under VMC—and if instrument rated pilots flying under IMC or at night could reduce their accident rate by ½—which is still at least twice as great as instrument-rated pilots flying in daylight under VMC, then approximately 200 general aviation lives would be saved per year. Such a reduction in the fatal and serious accident rate in general aviation is a reasonable goal of the National Airspace System plan. These goals are included in Table 2, in the text.

Obviously, weather problems are not the only source of general aviation accidents and fatalities. For example in 1979, 40 of the 4,023 accidents involved mid-air collisions between general aviation aircraft. The TCAS program addresses this issue. Furthermore, pilot proficiency seems to be a major cause of general aviation accidents. This is not directly addressed by the NAS plan.

CALCULATION OF FUEL BENEFITS

The forecast for 1992 air carrier fuel usage is 11.5 billion gallons, and a 6 percent saving assuming $1.00 per gallon amounts to 6 percent saving assuming $1.00 per gallon amounts to 690 million dollars. To this must be added 6 percent of the 33 percent of general aviation gas—at $1.92/gallon—that is assumed to be used for commuters. Also to this must be added 6 percent of the 38 percent general aviation jet fuel—at $1.73/gallon—presumed to be used for commuter aircraft. The remaining 6 percent of 67 percent of general aviation gas projected to be used in 1992 is the fuel benefits of piston-powered general aviation. Also, the remaining 62 percent of general aviation jet fuel projected to be used in 1992 is the fuel benefit of turbine-powered general aviation.

CALCULATION OF THE BENEFITS DUE TO REDUCED FAA O. & M. EXPENDITURES

The FAA projected a saving of approximately 1.4 billion dollars in 1992 in O&M expenditures that would have occured if this NAS proposal were not implemented. This saving arises from reduced requirements for AT and AF staffing and from reduced costs for communications, rents and utilities. Discounting this projection to approximately 70 percent, and recognizing that aircarriers and commuters will receive 95 percent of the reduction of the 60 percent that the Aviation Trust Fund plans to contribute to FAA's O&M expenditures and that turbine-powered general aviation would receive 3.4 percent of the 60 percent and piston-powered general aviation would receive 1.6 percent of the 60 percent, one arrives at the benefits of reduced costs indicated in Table 2.

Senator KASSEBAUM. Thank you.

Mr. Thomas?

Mr. THOMAS. Thank you, Madam Chairman.

My name is David D. Thomas. I have had a fair amount of experience with the system, having been a career FAA employee and I had something to do with the design, development, and operation of the present system as Director of the Air Traffic Service, Associate Administrator, Deputy Administrator, and Acting Administrator.

I am now serving as a consultant to the General Aviation Manufacturers Association. As a matter of interest, I am also serving on

the White House Science Council, the panel looking into the national airspace system plan, and I have heard considerable testimony on it. I am not reflecting any views of the White House Science Council because they have not yet come to conclusions, and it would be inappropriate for me to state them had they done so.

In general, I consider the plan a good one, I would like to join with the five former FAA Administrators who testified before the House Aviation Subcommittee endorsing the plan and suggested that we get on with it. Rather than going into detail, I would like to comment on some of the controversial issues I have heard today and which have arisen from the Office of Technology Assessment review.

As far as I know I attended all of the open meetings to which the industry was invited that OTA held over the 15 months or so they were looking into FAA plans. I am familiar with Dr. Gibbons' testimony, which seems to be based principally upon the thought that airport development will be the pacing and constraining factor, and the plan deals very lightly with this factor.

The OTA also concludes that FAA forecasts have been wrong in the past and are likely to be too optimistic in the future, and that forecasts provide the principal justification for the plan. They seem to think that, given airport constraints, there is little advantage to improving the en route system. A great deal of the plan does go to improve the en route system.

OTA suggests we buy time by increasing computer capacity where needed, by collecting and adding surplus outmoded computers similar to those needing replacement now. And they found that user charges based on excise taxes and fuel taxes produce internal cross-subsidies within the aviation community.

I would just like to speak briefly on each of those conclusions. Certainly airport development is a constraining factor, and I think the chairman's bill goes a long way toward solving this. We will not get much more airport real estate, but we can get some capacity improvements at existing airports and more new reliever airports. I think your bill, Madam Chairman, is very complementary to the NAS plan and is much needed.

On growth forecasts, I agree with Dr. Goldmuntz, that it really does not make any difference if there is zero growth. We need the plan now for increased capacity and for increased safety. A lot of the plan is not at all dependent on growth.

On the en route improvement, the plan certainly does improve en route capabilities, but it also looks at all airspace including terminal area requirements. It does not look at runways, which is part of the ADAP plan, but it does look at the terminal airspace as well as the en route airspace.

The whole centerpiece of the plan and what concerns most people, is the computer replacement. This is really a management decision, not so much a technical decision, of how to achieve the best new system while continuing to operate the present system. A dilemma really exists because the present software has to be used while new software is developed. The present software, made for the present computer, will make the transition difficult.

FAA studied the problem for several years, as the Administrator testified this morning, and reached the conclusion that going to a

modern host hardware system that will accommodate the present software and then will continue to provide service in the future with new software is the best. OTA recommended that the present obsolete computers now out of production, be augmented by more of the same type, to avoid the rehosting step until some final solution is found.

I don't know the best route, but it seems to me expanding present capacity while scavenging and refurbishing more of the same obsolete computers would be much like expecting the airlines to add capacity by using surplus DC–3's simply because they are available and the crews know how to fly them.

If I had to choose only between those two options, and there may be more, I would right now certainly choose the FAA recommendation because of much greater depth of study. And also, and a more important factor to me, they have the responsibility of having to live with the decision. But I hope the direction the system takes is to provide for rapid and continuous replacement of, or addition to, computer hardware.

The hardware and the software really should be transparent to each other so that one could add capacity, add computers, take computers out, and not get into a crisis situation like the one we are in now. I know I am partly responsible for the crisis situation because I was one of those responsible for the 9020 purchase which was then on the leading edge of the state of the art.

We thought we did a great thing, and as a matter of fact, we did, but computer technology is changing so rapidly that the 9020 generation of computers has been long since obsolete.

I would like to mention one more thing which has not been mentioned today, but I think is pertinent. OTA spent a lot of time examining internal cross subsidy, economic theories, but I think any attempt to fine tune the tax system and eliminate all individual inequities would lead to chaos.

We have had past experience with user charges in the form of excise taxes on passengers for air carriers and fuel for general aviation. The highway trust fund has worked very well for many years on a very simple formula, and I think that the user charges proposal made in your bill meet the test of reasonableness, fairness and simplicity without getting into all of the theories about cross-subsidies, I can give you any number of examples that will be for or against the airlines, the military, or general aviation about which one is subsidizing the other, depending on the nature of the flight and when and where it was made.

One criticism of the plan is it didn't spell out in great detail all of the steps that would be taken in the next 20 years. If it did, I would be very suspicious of it. I think its advantage is its flexibility.

Thank you very much.

[The statement follows:]

STATEMENT OF DAVID D. THOMAS, CONSULTANT, GENERAL AVIATION MANUFACTURERS ASSOCIATION

My name is David D. Thomas. I am a former employee of the Federal Aviation Administration. I started as an assistant airway traffic controller in 1938 and retired as Deputy Adminstrator in 1970. During my FAA service, I served as Director

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of the Air Traffic Service for seven years, Associate Administrator for two years, and Deputy Administrator for five years, which included nearly one year as Acting Adminstrator.

Since retirement from federal service, I have been active as a consultant on safety and airspace matters. At present, my commercial activities are limited to work with the General Aviation Manufacturers Association, but I also engage in some public service activities. Of possible interest to this Committee, I am now serving as a Member of the White House Science Council Panel on the National Airspace System Plan.

I wish to make it clear that the views I present here are my own and in no way presume to reflect the views of the White House Science Council. The Science Council work has not yet progressed to the conclusions stage and, in any case, it is inappropriate for me to comment on any proceedings of the Council.

During my latter years in the FAA, I participated in the planning and development of the system as it exists today as well as being one of those responsible for its day-to-day operation. With that background, I would like to offer some comments on the plan.

THE FAA NATIONAL AIRSPACE SYSTEM PLAN (NASP)

The NASP has been described variously as: "The most comprehensive plan ever developed by FAA"; "a collection of old bottom drawer plans that have been around for years"; "lacking in specific detail"; and as "a significant and bold step."

The Plan merits all of those descriptions. It does indeed incorporate pieces of plans for sub-systems that have been thought about for a long time and it is lacking in detailed cost and scheduling data. Further, as its critics point out, it is sketchy on airport planning, and airspace rules and configuration changes. With all of that, it is an excellent plan and I join with the five former Administrators who testified before the House Aviation Subcommittee on March 23, 1982, that ". . . the Plan is timely, comprehensive, and modern" and ". . . the Plan is worthy of support."

The five Adminstrators also noted that: "Like all good plans it is a guide and not a straitjacket. Lack of unanimity on every single detail should not impede progress on the totality of this excellent effort."

The keystone of the Plan is further automating the air traffic control process which will be possible only if the 1960 models of computers, display hardware, and software are replaced with modern equipment and software. A by-product of the planned enhanced computer capabilities will be the opportunity to consolidate many manned air traffic control facilities into fewer locations to gain even greater productivity increases through economies of scale.

Another key part of the plan is the orderly replacement of the present secondary radar beacon system—now tagged with the acronym "ATCRBS"—with a later version identified by the International Civil Aviation Organization as "Mode S." The principal difference between the two systems is that "Mode S" has a data link to discretely address and communicate with individual aircraft carrying the equipment, whereas the present ATCRBS system does not have a discrete address capability. In fact, the United States called this system "DABS" for "Discrete Address Beacon System" through its development and test years until ICAO designated it recently as a specific radar beacon mode. With discrete address capability, new opportunities are opened for much more automation in the whole process, including the basis for a wide range of capabilities in airborne collision and threat avoidance systems.

Obviously, there are many more elements in a $10 billion, or more, plan that covers 20 years, but the key management decisions are how to transition to new computer systems and programs, and how to introduce machine generated communications into the system while maintaining existing services.

OFFICE OF TECHNOLOGY ASSESSMENT REVIEW

I would like to comment on some controversial issues generated by the Office of Technology Assessment (OTA) review of the Plan. Although I had the privilege of participating in all of the sessions held by OTA to which industry members were invited, I cannot endorse their conclusions as presented to the House Committee on Appropriations, Subcommittee on Transportation on April 20, 1982, or to this Committee on May 24.

Perhaps oversimplified, the underlying themes of the OTA testimony appear to be:

1. Airport development will be the pacing and constraining factor; yet, the Plan deals lightly with this factor.

2. The principal justification for the Plan is growth forecasts made by FAA. FAA forecasts have been wrong in the past and are likely to be too optimistic.

3. Given airport constraints, there is little advantage to improving the enroute system.

4. Buy time by increasing computer capacity where needed by collecting and adding surplus outmoded computers similar to those that need replacement.

5. User charges based on excise taxes and fuel taxes produce internal cross subsidies within the aviation community.

Obviously, some case can be made for each of the positions taken by OTA, but in my view they failed to grasp some far more significant factors, such as:

1. Airport Development: Surely, continued airport development is essential to the growth of air transportation and the national economy. We need continuing legislation that provides for airport improvements and growth. Chairman Kassebaum's bill addresses this need effectively and is complementary to the NASP.

2. Growth Forecasts: The Plan is not dependent on the precision of growth forecasts. There is an urgent need to reduce the manpower intensity of the present system and replace its outmoded and inefficient equipment even if zero growth is projected.

Threat alert and collision avoidance systems, automatic weather reporting and dissemination, data link, greater computer capacities and flexibilities, and more efficient display systems are needed now.

The degree of growth should determine quantities needed; not types of equipment.

3. Enroute Improvement: Although OTA characterizes the Plan as principally affecting only enroute traffic, it actually looks at all airspace requirements including terminal area requirements. Even if there were no benefit other than to enroute traffic, much of the Plan would be justified by more direct routings, reduced manpower, and greater safety.

4. Computer Replacement: The centerpiece of the Plan is the replacement of obsolete computers and constrained software with modern equipment and programs with greater capability and flexibility. The selection of the "best" route is fundamentally a management decision of choosing between several options that will provide continuity of service during the transition.

A dilemma exists because the present software must be used for an indefinite future period while new software to handle more functions is developed, tested, and validated for use. Unfortunately, the present software is mated to the current computers and is not directly transferable to new hardware without intermediate steps.

The FAA has studied this problem for several years and reached a conclusion that going to a modern "host" hardware system which will accommodate current software and then provide service with improved software in the future is best.

OTA recommended that the present obsolete computers, now out of production, be augmented by more of the same type. This would avoid the rehosting step until some better final solution is found.

Although I had some influence in purchasing the first UNIVAC computers used in air traffic control, and the present IBM 9020 series were purchased "on my watch," I do not have enough knowledge to recommend the best route.

However, it seems to me that:

(a) Expanding present capacity by scavenging and refurbishing more of the same obsolete computers would be much like expecting the airlines to add capacity by using surplus DC-3s because they may be available and their crews know how to fly them.

(b) If I had to choose between only the OTA and FAA recommendations, without any further information, I would choose the FAA proposal because of greater depth of study and their responsibility of having to live with the decision.

(c) I hope that the direction the system takes is to provide for rapid—and perhaps continuous—replacement or addition of computer hardware. The new computer hardware and software should be independent to the extent that computer hardware can be changed as necessary to take advantage of new technologies without creating a software crisis whenever more computational or storage capacity is needed.

5. User Charges: OTA examined in some detail economic theories of cross subsidies in various user charge proposals. All tax schemes produce some individual inequities, and aviation user charge excise taxes are no exception. Despite numerous detailed economic studies purporting to "fine-tune" user charge philosophies, past history with aviation and highway user charges show that reasonable and more practical approaches work and are accepted.

The user charge proposals made by Chairman Kassebaum meet the tests of simplicity, reasonableness and balance between taxes and benefits. The Senator's pro-

posals will solve revenue problems on a reasonable basis. Further efforts to analyze, classify, and remedy internal cross subsidy situations will lead only to endless debate without practical resolution. A near infinite variety of internal subsidy examples can be found either in favor of—or against—air carrier, military, or general aviation users.

OTHER ISSUES

There are many issues in the Plan that are not completely resolved, but action need not be delayed waiting for final resolution. Among these issues are: future uses of satellites; mandatory or voluntary transition to Mode S and on what schedule; can one common weather radar type serve Commerce, Defense and FAA, or are separate systems needed to meet differing needs; to what degree must military ground and airborne equipment conform to the Plan; should long range heavy radar be continued; and a host of other issues that can be resolved only in the continuing crucible of experience and debate.

If the Plan did spell out all answers for the next 20 years with great precision, then I would be suspicious of it locking us into the year 2000 with 1980 technology. Surely, the Plan will change and evolve over the years as knowledge increases and circumstances change. The FAA has produced an excellent flight plan for the future and I urge that we get started on it with no more delay.

I appreciate this opportunity to express my views, and I will be happy to answer any questions you may have.

Senator KASSEBAUM. Thank you very much.

Dr. Goldmuntz, I would like to ask you some of the first questions, and I certainly would hope the other two of you would feel free to come in, particularly some of the concerns that AOPA has raised. AOPA believes it is not necessary to require the mode S below 12,500 feet.

Do you see any benefit to the VFR pilot to having that, and do you think the benefit would outweigh the $3,000 cost estimate for installation?

Dr. GOLDMUNTZ. I certainly do. A number of VFR pilots start out in VFR weather and end up in weather they cannot handle, and having a data link is a good way to get weather information updated all of the time so they don't get into that kind of a problem. So I think there is a safety benefit to have mode S. As the Administrator said, that will not be a requirement, but I would think that many general aviation pilots might want it for their own safety.

Senator KASSEBAUM. Even below the 12,000?

Dr. GOLDMUNTZ. Even below that to get up-to-date weather information as they are proceeding. They can get it by other means, but this is perhaps the best way to get it to them. Also, they can get instructions if they get in trouble and be directed to the right airport, something that will get them out of the trouble they are in.

Generation aviation's safety is something that has to be improved.

Senator KASSEBAUM. You heard Mr. Warner's testimony that he believed that it many times took them much out of their way and used more fuel and a longer amount of time. Would you concur with that?

Dr. GOLDMUNTZ. The current system does do that and that is exactly why the ATC process has to be modified to make it more efficient so that when you do enter into the system you will have more direct routes to your point of destination. The current system cannot accommodate that. It cannot make all of the computations necessary to insure you a safe and expeditious flight.

But if these modifications are made along the lines of the FAA proposal, I do believe a lot of the fuel will no longer be wasted and there will be direct origin to destination routings and I believe terminal airspace will be straightened out. At this point you must not overburden the controller. You unburden the controller by having the computer do some of the tasks appropriate to a computer, and you will have a more efficient system, both en route and in the terminal, which can get you to your destination faster.

That is what an ATC system should do, but we are limited now by the capability of our computer process.

Senator KASSEBAUM. Do you foresee a time when general aviation aircraft will be required to have the TCAS and the MLS equipment to operate into some airspace?

Dr. GOLDMUNTZ. I think to operate into some airspace but not all airspace. I think that is a judgment that has to be made at the time, when you see what traffic densities are like. That is the critical point, what will traffic densities be like at any point in time at any particular point in the system. In some places you may very well want to have all aircraft equipped and using MLS and TCAS, but I think it is too early to say that.

Some aircraft today in certain spots would be very much improved in their operations if they had TCAS and MLS, and Washington National is one such point.

Senator KASSEBAUM. Do you have any estimate of the extent to which general aviation pilots use the ATC system and the breakdown between tower facilities and en route facilities? Do you have any data on that?

Dr. GOLDMUNTZ. I don't have any independent estimate other than the statistics of the FAA, although I think the Administrator has said he would provide them for you.

Senator KASSEBAUM. Do you have any comments, Mr. Davis or Mr. Thomas, on any of these aspects?

Mr. THOMAS. I would like to comment on two things you just asked Dr. Goldmuntz. With regard to the mandatory provision for the carriage of mode S, the Administrator has said that on some date the manufacturers will stop making the current ATCRBS and from thereon only mode S would be available. I work with the manufacturers who will make the mode S requipment and who now make the ATCRBS equipment now flying in the system, and I hope the carriage of mode S is not mandated. If mode S is really beneficial, if it has the benefits we say, people will buy it. That has been the history of avionics. The users will make the transition because they get additional benefits.

I would hate to see opposition to the plan because it appears to mandate something about 1990. It uses words like "expected" and "will be needed," and the Administrator has said, rightly, this morning, that only time will tell. I would much rather see a long transition period, and if the benefits are there as we expect, people will buy the airborne equipment. The manufacturers will have no trouble selling them.

Senator KASSEBAUM. Dr. Goldmuntz, I have one last question for you. Although you were one of the originators of the AERA program, do you see any serious human factor problem stemming from extensive automation, particularly with the AERA 2 system?

Dr. GOLDMUNTZ. I was more a commentator, an integrator than originator. I don't want to take credit where none is due.

Sure there will be problems in interfacing any new system with people who are accustomed to doing business another way. I don't think any of them are insurmountable and I think that they will be accepted by the operators of this system and the users of this system, just the thing Mr. Thomas has said. There will be advantages to doing that. The workload on the controllers will be less. The expedition of flights will be greater.

But to say there will be no problems is, I think, unfair. It is a complicated system. It must work with enormous reliability. There will be training problems. There will be problems getting used to working in a new way. That is why you have to have a host computer that can take an evolutionary software, that can go from our current way of doing business to a more highly automated productive way of doing business step by step.

So the host computer will be ordered so that it can handle the more complex software evolution, but the software evolution will be just that. It will come along gradually and there will have to be some interchange between how controllers want the software to behave and how it does behave, just as in the current system.

Senator KASSEBAUM. Mr. Davis.

Mr. DAVIS. I would like to address the AOPA concern, and I really sympathize with the concern. They are worrying about spending a good part of what the airplane costs just for an extra box, the mode S box or the TCAS box. If you look at the box, what it looks like, the hardware of the box and how does it differ from the ATCRBS box which they carry, there are certain things in common: a transmitter, receiver, antenna, power supply, installation.

And then there is a processor. The difference between the two is the processor, the thing that handles the digits. The one in the ATCRBS is a very simple digital handling device. We are in a tremendous revolution, the so-called digital revolution. Chips are coming off the line for $5. You can buy an old INTEL microprocessor 8080, which is a very complicated processor. That particular processsor, which you can buy for $5 and in fact INTEL gives it to students so that they will buy INTEL products, has enough computing capacity, more than necessary to do the mode S job. I am not saying it will do it, but it has enough transistors on its chip to do it.

What is the message? The message is simple. Without any doubt, the mode S transponder can come down tremendously in cost. It is significant that, if I look at the organization of the FAA, they really have no one skilled in semiconductor art, nor have they gone to people skilled in the semiconductor art. It is called VLSI—I am sorry for the jargon—very large-scale integration. That has not been looked at. It should be looked at.

I am sure we are talking about a minimum change to the ATCRBS transponders, getting to the mode S when it is reduced to chips. That is very significant. The cost will not be $3,000. It will come way down.

Senator KASSEBAUM. You are suggesting just a change in the chips in the box?

Mr. DAVIS. I am saying the main difference is not so much in the expensive portions, which are the transmitter, receiver, antenna, and power supply, but in the processor, the thing that handles the bits, and that is one thing that is tumbling down in price and going up in capability beyond imagination. So that in the future there is a high probability that the mode S transponder will not be that expensive and the benefits general aviation will find by having it will gradually intersect with the cost because the cost will go down and the benefits will go up. I am pretty optimistic about that happening.

Senator KASSEBAUM. Does anyone else have any further comments?

Thank you very much.

The next panel, Mr. Martin, Mr. Howell, and General von Kann. It is a pleasure to welcome the three of you. I am sure you feel you have heard already a long morning of testimony.

Mr. Martin, Westinghouse Defense and Electronics Systems Center; Mr. Howell, executive central air safety chairman for the Air Line Pilots Association; and General von Kann, president of the National Aeronautics Association.

Mr. Martin.

STATEMENTS OF GEORGE E. MARTIN, WESTINGHOUSE DEFENSE AND ELECTRONICS SYSTEMS CENTER; JACK HOWELL, EXECUTIVE CENTRAL AIR SAFETY CHAIRMAN, AIR LINE PILOTS ASSOCIATION; AND GEN. CLIFTON VON KANN, PRESIDENT, NATIONAL AERONAUTICS ASSOCIATION

Mr. MARTIN. Thank you for the invitation.

I would also like to take the liberty of deviating from the prepared testimony.

First, I would like to change from good morning to good afternoon.

Senator KASSEBAUM. That is true.

Mr. MARTIN. I am George Martin, manager of systems engineering for the Command and Control Divisions of the Westinghouse Defense and Electronics Systems Center. Westinghouse command and control divisions are primarily involved in providing radars, communication switching systems, and automated command and control systems functionally similar to the computer replacement program in the NAS plan. We are not, however, pursuing this particular program.

Westinghouse has evaluated the NAS plan and believes that it achieves the FAA objectives and provides user benefits through increased services, better reliability and greater productivity. General aviation will benefit from much better weather information, which is their primary safety hazard. Airline delays will be reduced and much more direct routes can be flown. Both will reduce the fuel costs which are their major operational expense. The public will benefit by assured and enhanced safety and reduced costs of operating the system. From an industry perspective, the plan permits individual companies to target their own independent research and development to achieve a more competitive position for those programs they choose to pursue.

In the past, FAA plans were frequently changed and did not have the long-term stability to be used for corporate strategic planning. Consequently, many companies have chosen to target DOD markets. The DOD electronics industry is the same industry that is required to address the FAA programs. It is a shrinking industry which, if the FAA is to attract, it must have equivalent procurement policies, especially multiyear funding and equal progress payments.

Internationally, U.S. firms have been capturing a decreasing share of the air traffic control business. We are seeing systems internationally which reflect recent transition from military to civil applications. They are technically superior to much of the FAA's current equipment, particularly in the automated processing and display systems.

U.S. military technology is superior but it is not salable on a large scale for air traffic control because it is not in the FAA inventory and therefore does not have an FAA endorsement. The implementation of the NAS plan programs will again provide U.S. firms with superior endorsed products.

The importance of the international market is illustrated by the Westinghouse defense electronics business. Out of $1.3 billion in annual sales, about one-third is international. This international business equates to 6,000 jobs for Westinghouse, and it also generates an additional 12,000 to 15,000 jobs for Westinghouse vendors and their supplier facilities.

A rule of thumb for sales projections is that the international market is equal to the FAA market. One dollar of sales to the FAA will be matched by one dollar of sales internationally. The 1983 to 1987 $6 billion facilities and equipment program will generate over 300,000 man-years of work for U.S. industry. Another 300,000 man-years will be generated by international sales of the same equipment.

The FAA plan does not require, nor should it, technology which is pushing the state of the art. It is based on the proven technology which is mandatory to assure reliability and safety. We believe that the computer replacement program reflects this. It is structured with minimum risk to provide a system based on proven technology. The time scale is sufficient to permit an orderly program development without being forced to make totally positive assumptions.

If the program is delayed, this will not be the case. Reliability will be compromised because spares will become scarce even if a lifetime buy is made. There comes a time with any equipment when the reliability begins to decrease and the cost of operations exceeds the cost of replacing it. Automation is expensive but it has been shown in many areas to be more expensive not to automate. Improved quality and the resulting productivity which automation provides is as applicable to Government systems as it is to the auto, steel and consumer electronics business.

DOD systems are becoming more and more automated and have broken the ground that the FAA wants to follow. Not only will it cost much less to operate and maintain the systems, but productivity and effectiveness will be increased.

The FAA system must be replaced. If it is delayed by replacing one 1960's vintage system with another 1960's vintage system, the long-term problems will not be solved. Reliability of the system will decrease. The development and implementation cycle for the new system will be compressed and a truly high risk scenario will be in place.

In summary, Westinghouse believes the plan is by far the best the FAA has ever proposed. It is technically sound and has minimum risks. It has benefits for all users, including the public. It is adaptive, and the systems provided for it by U.S. industry will be attractive to the international community and provide a basis for U.S. export sales.

We strongly urge Congress to support the plan and provide 5-year authorization to implement it.

Thank you.

[The statement follows:]

STATEMENT OF GEORGE E. MARTIN, WESTINGHOUSE ELECTRIC CORP.

Good morning, Madam Chairman and members of the Aviation Subcommittee. I am George Martin, Manager of Systems Engineering for the Command and Control Divisions of the Westinghouse Defense and Electronics Systems Center. Westinghouse Command and Control Divisions are primarily involved in providing radars, communication switching systems, and automated command and control systems functionally similar to the computer replacement program in the NAS Plan. We are not however pursuing that FAA program.

THE PLAN

Westinghouse has evaluated the NAS Plan and believes that it achieves the FAA objectives and provides user benefits through increased services, better reliability and greater productivity. General aviation will benefit from much better weather information, which is its primary safety hazard. Airline delays wil be reduced and more direct routes can be flown. Both will reduce the fuel costs which are their major operationsl expense. The public will benefit by assured and enhanced safety and reduced costs of operating the system, both directly and in the unfunded pension liability which would be incurred by the additional personnel required if the plan is not implemented.

From an industry perspective, the plan permits individual companies to target their own independent research and development to achieve a more competitive position for those programs they choose to pursue. In the past, FAA plans were frequently changed and did not have the long term stability, compared to DOD plans, to be used for corporate strategic planning. Consequently, many companies chose to target DOD markets. The DOD electronics industry is the same industry which is required to address the FAA programs. It is a shrinking industry, which if the FAA is to attract, it must have equivalent procurement policies, especially multi-year funding and equall progress payments. With the high cost of money and the increased emphasis on cash flow, a prudent manager must often choose to apply his resources on a DOD program which has 90 percent of cost progress payments vs. the FAA's 80 percent.

Internationally, U.S. firms have been capturing a decreasing share of the ATC business. We are seeing systems internationally which reflect recent transition from military to civil applications. They are technically superior to much of the FAA's current equipment, particularly in the automated processing and display systems. U.S. military technology is superior but is not saleable on a large scale because it is not in the FAA inventory and therefore does not have an FAA "endorsement." The implementation of the NAS Plan programs will again provide U.S. firms with superior "endorsed" products.

The importance of the international market is illustrated by the Westinghouse Defense electronics business. Out of $1.3 billion in annual sales, about ⅓ is international. This equates to 6000 jobs for the Westinghouse Defense and Electronic Systems Center. Using a Westinghouse Econometrics model accepted by the Export-Import Bank, this business generates 12–15,000 jobs for Westinghouse vendors and their supplier facilities.

A rule-of-thumb for sales project is that the international market is equal to the FAA market. One dollar of sales to the FAA will be matched by one dollar of international sales. If the same Westinghouse Econometrics model is applied to the 1983–87, $6 billion Facilities and Equipment Cost, over 300,000 man years of work will be generated. Another 300,000 will be generated by international sales of the same equipment.

The FAA plan does not require, nor should it, technology which is pushing the state-of-the-art. It is based on the proven technology which is mandatory to assure reliability and safety. We believe that the computer replacement program reflects this. It is structured with minimum risk to provide a system based on proven technology. The time scale is sufficient to permit an orderly program development without being forced to make totally "positive assumptions." If the program is delayed, this will not be the case. Reliability will be compromised because spares will become scarce, even if a lifetime buy is made. What is the lifetime? And when do the non-proprietary parts begin to experience the once in a lifetime failures? How many vendors will want to make investments to pursue a dying market?

There comes a time with any equipment where the reliability begins to decrease and the cost of operations exceed the cost of replacing it. Automation costs, but it has been shown in many areas that it is more expensive not to automate. Improve quality and the resulting productivity which automation provides is as applicable to government systems as it is to the auto, steel and consumer electronics business. DOD systems are becoming more and more automated and have broken the ground that the FAA wants to follow. Not only does it cost much less to operate and maintain the systems but production and effectiveness is increased as witnessed by the recent Israeli air-to-air successes which were directed by U.S. supplied automated control systems.

The FAA computer system must be replaced. If it is delayed by replacing one 1960's vintage system with another 1960's vintage system, the long-term problems will not be solved. Reliability of the system will decrease. The development and implementation cycle for the new system will be compressed and a truly high risk scenario will be in place.

The existing ATC system is the result of systems growth to meet increasing demands. Essentially everything purchased since 1937 is in the field. It will be replaced, either as part of an orderly overall systems plan or on a crisis basis depending on where the fire drill is today.

THE FIRST FIVE YEARS

The first five years of the plan are critical. During this period 49 of the 97 projects in the plan will be completed, 35 will have started field implementation, 6 will be in the R&D phase, and 7 will commence after this period. Multi-year authorization is required if the FAA is to implement this plan. This will assure that the U.S. will regain the lead in Air Traffic Control systems and continue to have a safe, reliable system. This will convey to the FAA people at headquarters and the field, controllers and enginers, U.S. industry and overseas civil aviation agencies that this is not just another redirection of the FAA, but that it's backed by Congress, it's real, and appropriate plans can be made in relation to it.

However, we do believe that the FAA must institute some management direction to reduce the time it takes to go from an RFQ released to industry to a contract. For programs such as those in the NAS plan, this has been typically 13–15 months. This must be reduced if the plan is to be implemented on schedule.

IN SUMMARY

Westinghouse believes that the plan is by far the best the FAA has ever proposed. It's technically sound and has minimum risk. It has benefit for all users including the public. It's adaptive and the systems provided for it by U.S. industry will be attractive to the international community and provide a basis for U.S. export sales. We strongly urge the Congress to support the plan and provide a five year authorization to implement it.

Senator KASSEBAUM. Thank you.

Mr. Howell.

Mr. HOWELL. Madam Chairman, I am Jack Howell, executive central air safety chairman for the Air Line Pilots Association.

I also fly the 727, for one of the air carriers operating principally here on the eastern coast of the United States, and generally we in

ALPA find this plan to be a highly commendable effort which consolidates into a single document equipment requirements, implementation goals, and R&D efforts necessary for airspace modernization.

To summarize our 12-page written testimony, I will discuss 11 specific aspects of program elements which need to be emphasized within the first 5 years.

COMMITMENT TO ADEQUATE FUNDING

It is critical that a source of funding be identified and that legislation be enacted that would clearly signal that the Federal Government will proceed with implementation of the NASP. The airport and airway authorizing legislation could provide the vehicle to accomplish this goal. With your help and the help of your compatriots in the House, our concerns over the establishment of adequate funding levels may well disappear.

PROGRAM MANAGEMENT

For the principal reason of continuity, the FAA should carefully consider assigning overall program management responsibility to a single non-government contractor with support teams of FAA personnel.

AIRPORT CAPACITY

The program must include a vigorous effort directed at the airport capacity problem. Otherwise, all the planned improvements will only result in air carriers sitting on the ground waiting for a departure time from the new system or holding "in style" while waiting for an approach time.

CENTRAL FLOW CONTROL

Presently, airport and airway capacity predictions are so inaccurate that great inequities and unnecessary delay result when central flow control is in effect. Thus, ALPA believes that the function of the central flow control facility itself should be limited to providing advisories to air traffic facilities and operators about abnormal system conditions and expected demand and probable delay at specific facilities. Central flow control should not become involved with allocating delay to specific aircraft.

EN ROUTE METERING

We believe ATC should not become involved in attempting to do flight profile optimization except to derandomize arrival intervals to the legal separation minimum. Instead, ATC should concern itself with permitting each operator to determine the flight profile in his own individually optimized way as dictated by in-flight conditions and onboard computers.

CONFLICT ALERT AND CONFLICT RESOLUTION ADVISORIES.

Improvements to the existing conflict alert system should not in any way be allowed to slow the development and implementation

of an airborne collision avoidance system because conflict alert will always be a far less capable and less reliable collision avoidance tool. Furthermore, planned improvements like the advisory function which provides a list of conflict resolution options to the controller may not be cost effective.

SECTOR SUITE AND SOFTWARE REDESIGN

Sector suites will likely improve reliability and availability of information, but much of the limitations of today's controller to handle traffic will remain, and that is the communications burden plus the human controller's own ability to assimilate all the information and provide timely clearance information to the aircraft.

AUTOMATED EN ROUTE AIR TRAFFIC CONTROL

The plan description of AERA dwells on "aiding the controller in preparing and issuing fuel efficient clearances" and "detecting and resolving conflicts with severe weather." It is our opinion that the primary function of AERA should be to resolve real time conflicts en route and the secondary function should be to recognize potential long-term conflict and so advise the operators.

TCAS

The TCAS II system described by Mr. Helms meets ALPA criteria for an effective collision avoidance system and such a system is essential when you consider such things as increased levels of automation, reduced aircraft separation standards, and expanded areas of responsibility. These, coupled with the potential effects of hardware or software failures, enforce the need for an independent backup system capable of maintaining an adequate level of safety.

COCKPIT DISPLAY OF TRAFFIC INFORMATION

For us, the pilots, the big payoff for CDTI comes from the safety side of the automation and consolidation aspects of the overall plan. CDTI offers the capability of allowing for that "impossible ground-based computer glitch, the power outage, or the human failure. With an airborne data base it permits an independent backup conflict resolution mode and a means for permitting "distributed monitoring" of the automated ATC processes.

WEATHER DISSEMINATION

Development of a new ground-based weather radar is essential considering the old age, limited operational capabilities and the poor maintainability of existing weather radars. Equally important, however, is an improvement in the methods by which real-time weather reports will be provided to pilots in flight.

In summary, we support the NASP and the various elements of which it is comprised, and we pledge to assist the FAA in implementing the plan as well as urging the Congress to grant appropriate funding. We do hope, however, that within the first 5 years, even within the first year, the FAA will take steps to provide a strong commitment to a seasoned management structure and a reorientation of philosophy from ATC improvements for the benefit

of ATC to one of ATC improvements for the benefit of air transportation.

Thank you.

[The statement follows:]

STATEMENT OF JACK HOWELL, EXECUTIVE CENTRAL AIR SAFETY CHAIRMAN, AIR LINE PILOTS ASSOCIATION

Madam Chairman and Members of the Subcommittee, I am Jack Howell, Executive Central Air Safety Chairman of the Air Line Pilots Association. ALPA represents the professional interests of 33,000 pilots who fly for 36 airlines. With me today is John O'Brien who is Manager of Engineering and Operations for ALPA.

We are pleased that you and the members of your committee are reviewing the FAA's National Airspace System Plan (NASP) with particilar emphasis on the first five years of the program, and we are even more pleased to have the opportunity to provide some operational considerations for your review.

OVERVIEW

The line pilots we represent have been delegated by Federal Aviation Regulation with the statutory responsibility for the safety of the millions of passengers who utilize our National Airspace System (NAS). Because of this legal responsibility and the unique position we hold, we believe we are able to provide special and unique insights into the realities of daily airline operations. ALPA, through membership input, recognizes the need to modernize the airspace system, and we have reviewed certain aspects of the FAA's new National Airspace System Plan to determine how it will impact our use of the airspace. In general we find the Plan as proposed by the FAA to be a highly commendable effort which consolidates into a single document equipment requirements, implementation goals, and essential support to the R&D efforts necessary for airspace modernization.

We do, however, have some overall reservations about its usefulness as well as some specific suggestions for prioritizing the improvements. The reservations we have relate to the establishment of adequate funding levels, the management capabilities of the FAA, and the lack of consideration of airport capacity in the plan. The suggestions we have for prioritizing the improvements spring from our concerns over safety and economies of flight. Thus, the FAA accomplishments in the first five years of the program are of great interest to us for they will set the tone of accomplishment for the entire Plan.

RESERVATIONS

Commitment to Adequate Funding: The successful implementation of this Plan depends on many factors, the most important of which may be the establishment of adquate funding levels over a significant period of time. It is critical that a source of funding be identified and that legislation be enacted that would clearly signal that the Federal government will proceed with implementation of the NASP. The airport and airway authorizing legislation could provide the vehicle to accomplish this goal. With your help and the help of your compatriots in the House, our concerns over the establishment of adequate funding levels may well disappear.

Program Management: As presented, the Plan shows all efforts flowing smoothly in parallel even when the objective of one program is completely dependent on the results of other efforts. This is a necessary, but ambitious ingredient of the Plan if the proposed implementation dates are to be met. But it creates a challenging management task—one which FAA may not be capable of undertaking.

To assure successful implementation, a total "systems management approach" must be employed by FAA. In such a total systems management approach computer hardware and software would be the responsibility of appropriate contractors and yet implementation of the various aspects of the Plan would be the responsibility of a single executive authority. In the past, for various reasons—not all within the control of the Administrator (National elections, retirements, funding changes, technical evolution)—the FAA has not been able to maintain the management resources necessary to direct large scale, complex programs from conceptual stages through full implementation. The history of the Microwave Landing System (MLS) and Collision Avoidance System (CAS) programs illustrate this point. For this reason FAA should carefully consider assigning overall program management responsibility to a single contractor with support teams of FAA personnel from ATS, ATF, AS, R&D, OSEM, etc.

In a very recent development we have learned that the FAA is considering the establishment of a special in-house management team and is considering contracting for outside system management help. If FAA takes positive action in this area, one general reservation we have over successful implementation of this modernization plan will be eliminated.

Airport Capacity: One of the weakest points in the Plan is the lack of consideration for airport capacity. FAA forecasts of aviation activity and the resultant demand on airports, even if only roughly accurate, indicate that the current airport/airway system cannot accommodate expected growth without delays of "30 minutes per operation" during peak hours at the Nation's major airports. The FAA airspace system modernization program must include a vigorous effort directed at the airport capacity problem. Otherwise, all the planned improvements will only result in air carriers sitting on the ground waiting for a departure time from the new system or holding "in style" while waiting for an approach time. Resolving this problem is a major task which must be addressed.

The start should be a firm commitment to seek major capacity improvements. For example, to shrink landing aircraft separation, FAA should work with NASA to find ways to reduce wake vortices not just determine where they are. Runway occupancy times need to be reduced. Furthermore the joint use of military airports in close proximity to busy population centers should be aggressively pursued along with a program to provide many more general aviation reliever airports. In brief, the Plan should contain positive commitments toward resolving the airport capacity problems. Recognizing the jurisdictions involved, the solution to this problem will require leadership from a high executive level within the Administration.

We do, however, take encouragement from the fact that the FAA plans to assemble an industry committee which will study and make recommendations concerning the means to increase airport capacity, and that ALPA has been asked to participate on the committee.

SUGGESTIONS FOR PRIORITIES

The recurrent theme throughout the Plan is that safety and efficiency will be "chiefly realized" through higher levels of automation and consolidations of major facilities.

Consolidation of certain ATC facilities and functions can obviously improve some operational efficiencies and certainly reduce personnel requirements. This was demonstrated by the elimination of some ARTCC sectors as a result of the PATCO strike. Still, consolidation—at some point—can compromise the ability of the system to provide an adequate level of service, and the needs of all system users must be addressed in implementing this aspect of the modernization. For example, the controller seated in the "sector suite" must not be swamped with a myriad of data and responsibilities which exceed his human abilities. It is clear that human factors specialists must work with the primary users in reaching consolidation decisions. Furthermore, payoff in the consolidation effort will only be realized if the required automation can be implemented in an operationally acceptable form.

The determination of an "operationally acceptable form" has led ALPA to cite some improvement priorities for a variety of the sub-systems described in the Plan.

Central Flow Control: Presently airport and airway capacity predictions are so inaccurate that great inequities and unnecessary delay inevitably result when Central Flow Control is in effect. In addition, attempts to control or modify demand produce a chain reaction of flight plan changes made independently by the users with the result that the original flow and delay predictions are no longer valid. As a greater proportion of IFR traffic shifts to the unscheduled sector, this problem will be compounded. Thus, ALPA believes that the function of the Central Flow Control Facility (CFCF) itself should be limited to providing advisories (to air traffic facilities and operators) of abnormal system status (weather, equipment outage, etc.) and expected demand and probable delay at specific facilities. CFCF should not become involved with allocating delay to specific aircraft.

En Route Metering: The concept of taking unavoidable delay at high altitude is supported by ALPA but we believe ATC should not become involved in attempting to do flight profile optimization except to de-randomize arrival intervals to the legal separation minimum. The reason is simple: Even though the ground-based scheme can consider many variables, it cannot take into account the variety of anomalies with can occur on a single aircraft. Instead, ATC should concern itself with permitting each operator to do that task in his own individually optimized way as dictated by in-flight conditions and on-board computers. Thus, this metering program must be developed in such a way as not to negate the potential advantages from using on-

board Flight Management Systems (FMS) and the program must allow operational flexibility to deal with a variety of flight anomalies. Flight Profile Management should be left to the aircraft operators.

Conflict Alert and Conflict Resolution Advisories: Improvements to the existing conflict alert system should not in any way be allowed to slow the development and implementation of an airborne Collision Avoidance System because conflict alert will always be a far less capable and less reliable collision avoidance tool. Furthermore, improvements like the advisory function which provides an alternative list to the controller may not be cost effective. In fact, it may even delay the transmission of conflict resolution information. Once a controller is alterted to a conflict, a resolution normally is immediately apparent to him. Giving him a list of options from which to make a choice will likely to be time-consuming, and the delay might heighten the severity of the conflict.

Sector Suite and Software Redesign: The Concept of providing a controller with improved tools is a good one. However, it is possible the authors of the Plan have credited this suite with more than it is capable of providing. It will likely improve reliability and availability of information, but much of the limitations of today's controller to handle traffic will remain—the communications burden (frequency congestion, misunderstanding and all the other problems of radio transmissions) plus the human controller's own ability to assimilate all the information presented to him and provide timely and correct clearance information to the aircraft under his jurisdiction. If the computer will do his observing and thinking for him, and the controller merely relays information printed on the screen to pilots, he should clearly be replaced by data link. If the computer does not do this, a controller with a sector suite will have must better working quarters, but he will not be measurably more productive.

Automated En Route Air Traffic Control: While ALPA strongly supports the planned computer replacement program, it appears the design of the AERA software program will determine, more than anything else, the efficiency and capacity of the future ATC System. If this is done correctly, the future looks very bright. However, since the description of AERA contained in the Plan is so general, implications of a terribly inefficient system can be drawn by a reader, especially if he interprets the heavy emphasis on ground based management as an indication of the removal of operational control from the airspace users. Yet Mr. Helms has publicly stated on a number of occasions that it is his intent to "control but not constrain" aviation. While this phrase is almost a contradication of terms, he clearly implies a relaxing of FAA's control over flight operations. This is a most welcome commitment, and it comes at a time when fuel price and availability will demand it, and onboard Flight Management Systems require it. Indeed, the capacity of the airspace is sufficient to handle a quantum increase in traffic quite easily with minimal constraint to any individual flight in the en route airspace.

The NASP description of AERA, however, never mentions accommodating user-derived flight plans! Instead, it dwells on "aiding the controller in preparing and issuing fuel efficient clearances", and "detecting and resolving conflicts with . . . severe weather". If AERA is properly developed, it can assist the operators with these functions, but AERA must leave final decisions to the aircraft operators who are the only ones in a position to make proper judgments. Determining a flight path for optimum efficiency and to avoid weather hazards must be done by the aircraft operators; as it is, it will be extremely variable from one operator to the next, depending on many different factors comprising his operation. In addition, this flight path determination must be long in both time and distance and conflict resolutions with other aircraft must result in relatively minor perturbations to the overall plan. Therefore, the implied AERA proposal to do a long-term conflict probe first and then try to fit in efficiency afterward is puting the cart before the horse. It also reflects the manual control mentality, which requires a human controller to take a long look ahead since he is too slow to resolve a very near term multiple conflict situation. The computer need not be so limited. AERA can and should be a program to permit maximum flexibility (minimum constraint) and to resolve conflicts en route at the time such resolution becomes necessary.

Thus, the primary function of AERA should be to permit maximum operational flexibility through resoliving real time conflicts en route as this function becomes necessary and the secondary function should be to recognize potential long-term conflict and so advise the operator. These functions can be accomplished safely through proper inclusions of CDTI and TCAS II.

The issue of safety in automated ATC has not been sufficiently addressed by the Plan. The fail-soft feature of distributed processing in the sector suites will apparently not permit the continue functioning of AERA in the event of a central com-

puter outage. No human controller can quickly and adequately take over an entire saturated sector in the event of an AERA failure. Therefore, a fully functioning TCAS II system must be in place under the AERA concept, and CDTI must also be implemented so that each pilot can at least watch out for this own single aircraft in relation to those around him. Such a system is already endorsed by FAA now, with far less reliable information, it is called "see and avoid". CDTI represents an improvement in accuracy and reliability of relative position information and an extension of these rules to possible IMC conditions, when used in conjunction with AERA.

TCAS: One of the basic assumptions of the Plan is that no change to the ATC System will be permitted to reduce safety or increase risk. To maintain the existing level of safety and to reduce risk, the FAA claims that a very high level of mid-air collision protection, including an independent airborne separation device called TCAS, will be available. In fact "see and be seen operations, which will continue, may be supplemented by new systems. Self-separation may be feasible in some airspace".

We do not question the availability of TCAS in all of its proposed versions (TCAS I, II and advanced II). What we do question is whether all appropriate airspace users will voluntarily equip with this system unless implementation is mandated by FAA in a manner similar to the Mode S mandate. Unless at least all air carrier aircraft are equipped with TCAS II, we believe the ATC System safety will be jeopardized.

Our concern over airborne Collision Avoidance Systems goes deeper than just a desire to see implementation mandated. We also have very strong feelings about the type of system that is carried on board air carrier aircraft. ALPA has been on record, for several years, supporting the requirement for a Collision Avoidance System that provides the pilot with both proximity warning information and the ability to make horizontal escape maneuvers as well as vertical. These capabilities are necessary if the system is to operate in dense traffic areas and if adequate consideration is given to aircraft maneuvering capability at high altitude as well as at low altitude in the terminal area. The TCAS II system described by Mr. Helms will be capable of meeting these requirements.

A capable CAS system becomes even more important when you consider such things as increased levels of automation and expanded areas of responsibility for various ATC facilities through consolidation. These, coupled with the potential effects of hardware or software failures, enforce the need for an independent backup system capable of maintaining an adequate level of safety until such time as the ground system can again assume primary responsibility for separating traffic after such a failure.

CDTI: The Air Line Pilots Association is concerned that the potential role of Cockpit Display of Traffic Information (CDTI) in the new ATC system has been clouded both by exaggerated claims of some of its proponents and by those whose interest in competing alternatives prevents a positive approach toward developing the concept into a working reality. The tests of the CDTI concept to date by FAA and NASA have shown to everyone's satisfaction that substantial capacity gains may be achieved through pilot-controlled spacing on in-trail arrivals and departures using common paths. Even ignoring the other possible improvements to air traffic system capacity (such as paralleled approach monitoring, terminal area merging, en route station-keeping, passing control, etc.), the in-trail spacing alone would justify use of the concept at the earliest opportunity.

In the past, two factors have delayed implementation of the CDTI concept: the availability of a data source to drive the display and the availability of an adequate cockpit display. The data source could be the ground-based ATC system utilizing a data link as a communication channel. However the decision to implement TCAS II on most of the aircraft which use the capacity-restricted airports, coupled with the availability of either an electronic HSI or at least a digitized weather radar CRT on those same aircraft provide both the source of traffic information needed by CDTI and the instrument panel location for its display. While it may be an over-simplification of how CDTI could be implemented, all that would be necessary would be to add a paragraph to the Controller's Handbook permitting the issuance of an IFR clearance to a CDTI-equipped aircraft which would permit this aircraft to follow an identified aircraft at a specified distance. The Automated En Route Air traffic control (AERA) concept could be enhanced by CDTI by just such a clearance capability.

But for us the big payoff for CDTI comes from the safety side of the automation and consolidation aspects of the overall Plan. CDTI offers the capability of allowing for that "impossible" ground-based computer glitch, the power outage, or the human failure. With an airborne data base it permits an independent back-up con-

flict resolution mode and with all the consolidation that is contemplated any ground equipment failure will involve a lot of airspace and a lot of airplanes.

While the potential benefits to both capacity and safety in the ATC system are great, CDTI does not represent a fundamental change to the ATC system. It does not represent "do-it-yourself ATC", and ALPA has never said that it could or should. Rather, it takes advantage of the TCAS data processing capabilities and the CRT display technologies already being installed in transport aircraft and permits the use of this new information to be exploited for capacity improvements, reduced controller workload, fuel savings, and safety. Simultaneously it allows for the only possible human monitoring of the entire automated traffic controlled process. Each airplane could see his own situation. The traffic situation display would become a "total situation display", distributed management would become "distributed monitoring".

Weather Dissemination (NEXRAD): The Plan is optimistic about improving the dissemination of weather information via the ground system, but does not describe methods by which real-time weather reports will be provided to pilots in flight. There must be a strong commitment by the FAA to provide real-time information to pilots in flight directly or at the pilot's request. Data link transmission of sequence reports alone will not satisfy this requirement. In this regard, development of a new ground-based weather radar is essential. NEXRAD should be a priority item, considering the old age, limited operational capabilities and the poor maintainability of existing weather radars. Because over fifty percent of all aviation accidents are to some extent weather related, the need is unquestionable.

Senator KASSEBAUM. Thank you.

General von Kann.

General VON KANN. Madam Chairman, thank you for bringing this important project along to the point where it is close, I think, to legislation and implementation. I guess I am the cleanup man here, and that is appropriate, because NAA——

Senator KASSEBAUM. You can summarize the whole thing.

General VON KANN. Yes, that is what I plan to do, in 2 minutes,

We do think we look at it from the standpoint of all of aviation and what is good for the country as a whole.

Madam Chairman, this has been an excellent hearing, because it has demonstrated the strength, the thoroughness, and the practicality of the FAA plan, which is a true system plan in every sense. And it also has demonstrated the weaknesses of the questions raised about the plan, which seem to come in the category of failure to understand the plan, or in nuts and bolts types of concerns which can be readily resolved.

Madam Chairman, for more than 30 years we have been studying and restudying the airways. At one time, when I was in the ATA, we concluded there was a new study or a new plan every 2 to 3 years, and each one would overtake and kill the previous study. Fortunately, the only good thing about this process is that we have before us the best plan and the most comprehensive one to date. And now we have reached a point where we can no longer delay.

If we do not move, the deterioration in the system will reach crisis proportions soon, system costs will become unbearable, and the Nation will pay a heavy price in loss of leadership, loss of jobs, and reduced national security. This hearing, then, reinforces my position that the FAA plan, supplemented by an effective airport construction program with particular attention to reliever airports, will respond to the needs of the total aviation community.

No element of the community will get everything he or she wants, but everyone will gain significantly, and so will the Nation. The plan is not inviolate and undoubtedly will need to be modified in the course of implementation. However, it is extremely flexible,

and we all know it is easier to modify an ongoing plan than no plan at all, which is where continued debate will leave us.

Madam Chairman, we have the man in Administrator Helms, the technology is here, and it's up to us to see that we put them to work and capitalize on them. We, therefore, should move forward with a multiyear authorization to provide continuity and transition of management to send a clear signal that this is our program and to get it established.

NAA therefore strongly supports the FAA plan and S. 508 with a 5-year authorization.

Thank you for bringing this vital matter to the point of legislation and implementation.

[The statement follows:]

STATEMENT OF CLIFTON F. VON KANN, PRESIDENT, NATIONAL AERONAUTIC ASSOCIATION

Madam Chairman and Members of the Subcommittee, on behalf of the more than 250,000 members of the National Aeronautic Association (NAA), its chapters, divisions and affiliates, I appreciate the opportunity to comment on current plans and legislative proposals for airway and airport modernization and development.

This matter has absorbed much of your time and energy, Madam Chairman, as well as that of Senator Cannon and of key members of this and other responsible committees. Because the subject is complex, any less energetic effort would probably have failed. But the program at hand cannot be allowed to fail. Because of the wisdom and resolve which you, and Senator Cannon and the Subcommittee have displayed, I don't think it will.

BACKGROUND

In April I submitted to this and other interested Committees of the Congress a statement summarizing NAA's views on airway and airport improvement—and its effect on U.S. aerospace leadership. In May I submitted a statement for the record in connection with last month's hearing before this Subcommittee. I assume that these statements, along with today's remarks, will become part of the record.

For purposes of this hearing I will summarize the overriding points which bear on current technical and legislative proposals.

Since my testimony will touch on some of the more technical aspects, it is appropriate for me to note my own qualifications as a witness. From 1965 to 1980, I served as the Chief Operations and Technical Officer of the Air Transport Association. During that period my main preoccupation was airway and airport capacity—or, more precisely, how lack of capacity was contributing to system delays, breakdowns and restraints. I participated in the creation of the aviation community coalition known as ACCENT, which sought to deal with the problems of system capacity. Between these experiences and the fact that I still fly the airways today as an instrument rated commercial pilot, I think I understand the problem and the needs of the users.

While the past two decades have seen growing concern about the inability of the system to cope with increasing demand, it also became apparent that unless FAA assumed a leadership role, little improvement could be expected. After all, what plan can be implemented without the agreement and enthusiastic support of the government official responsible for the safety and efficiency of the system? Now, under Administrator Helms' initiative, FAA has at last assumed the leadership role. And now we have a well thought out and workable plan to bring system capacity and public demand into balance. It should be noted that this plan resulted from an intensive ten month effort, personally led by Administrator Helms, which marshalled the best available talent from FAA and from the civil sector. It was the most complete effort of its kind ever undertaken.

OPPOSING VIEWS

It is sad but true that in the Washington Establishment, the appearance of any major proposal results in a reaction that resembles an anti-aircraft barrage during the a World War II air raid on London. This usually happens without regard to the merits of the proposal. While the FAA National Airspace System Plan has received

less flack than most new proposals, it has been on the receiving end of some criticism by the Office of Technology Assessment. Since this organization has the prestige of being an arm of the U.S. Congress, its pronouncements are given a fair amount of weight—in this case, more than they deserve. I would therefore like to comment on the OTA critique of the FAA plan.

The OTA critique is based largely on its own study of the airport and air traffic control system which was completed at about the same time as the FAA plan. The two studies have different premises, however. OTA concludes that growth must be restricted by various governmental actions; FAA concludes that the technology is available to make the airspace system meet public demand at reduced cost—and that if these improvements are accompanied by a comparable expansion of airport capacity, there will be no need for the government to control demand. Since most government efforts of this type have caused more problems than they have solved, the FAA approach is far more attractive and more consistent with the principles of a free economy.

There is another major difference in the FAA and OTA positions. The FAA Administrator is responsible for the safe, efficient and economical operation of the system; OTA is not. In view of the present Administrator's exceptional qualifications and track record, OTA's objections to the FAA plan do not seem persuasive. If Administrator Helms says "This is the way to replace the current computers" and OTA says "No. There is a better way"—I have to believe Administrator Helms. In any event, FAA's approach to computer replacement makes more sense on the face of it since the key problem is to keep the system going at minimum risk.

Finally, OTA makes a great fuss about FAA forecasts. OTA's concern here is just plain wrong. I have been closely involved with FAA forecasts for over 15 years. Up to 10 years ago these forecasts were sometimes high and sometimes low. In the past decade FAA's technique has been improved and updated; resulting forecasts have been quite respectable and adequate for planning. In any event we all know that demand will grow, and that if something isn't done our entire air transport system will be crippled.

OTA has also expressed concern about the responsiveness of the FAA plan to the needs of general aviation. In view of the fact that the plan has received strong support from a number of general aviation groups, this concern seems unfounded. I have also been informed that an independent analysis of capital cost recovery, to be presented here today, will demonstrate a faster cost recovery for general aviation than for the air carriers.

The general aviation fuel tax has also received much comment. Now I am as concerned as anyone about the increasing cost of flying. All costs, including local taxes, are steadily rising. But whether the general aviation fuel tax is 8½ or 12 cents per gallon will make little or no difference in this picture. If I can afford to fly a small piston plane 10 hours a month (which is questionable), the difference between 8½ and 12 cents a gallon will be $4.20—not very much compared to other costs of roughly $40 per hour.

THE NEED TO MOVE AHEAD

My point, Madam Chairman, is that we could argue indefinitely about various aspects of a plan which is clearly comprehensive, well conceived and practical. These arguments fail to recognize that if we don't act promptly:

The deterioration in the system will soon reach alarming proportions;

System costs will soon become unbearable; and

The Nation will pay a heavy price in loss of leadership, loss of jobs and reduced national security.

The FAA Plan, supplemented by an effective airport construction program—with particular attention to reliever airports, will respond to the need of the total aviation community. No element of this community will get everything that he or she wants, but everyone will gain significantly.

The plan is not inviolate and undoubtedly will need to be modified in the course of implementation. However, it is easier to modify an on-going plan than no plan at all—which is where continued debate will leave us.

We therefore must move forward with a multi-year authorization to provide continuity of transition and of management—and to send a clear signal that this is our program.

If S. 508 is amended to provide for a multi-year program of five years, it can provide the legislative vehicle for proceeding with this important national undertaking.

NAA therefore strongly supports S. 508 with the five year authorization.

Once again, I thank you, Madam Chairman, and Senator Cannon for your efforts to keep this program moving forward.

This concludes my statement. I will be happy to respond to your questions.

Senator KASSEBAUM. Thank you.

Mr. Martin, I would like to ask you, because of your work with the defense establishment and systems analysis there, the concept behind the plan is to create sufficient redundancy in the system to provide as fail-safe a system as possible. Do you believe the host computer and sector suite approach will achieve that goal and is the approach taken by the FAA similar to the approach taken by the Department of Defense in their command control technologies?

Mr. MARTIN. The answer to both questions is yes. Distributive processing is the phrase we use in being able to reassign automatically the computing and software resources in case of failures. It is very much state of the art at the moment.

Senator KASSEBAUM. And you believe, I assume, this?

Mr. MARTIN. Yes.

Senator KASSEBAUM. Mr. Helms stated in his testimony that because the systems approach is used it is difficult to analyze discrete pieces of the system, such as the host computer technology, without taking consideration of the rest of the system. As a systems engineer, do you agree with that concept?

Mr. MARTIN. You certainly want to do your analysis and design from the top down, but you do get down to the fragments of the system. And the computer system I hate to describe as a fragment, but that seems to be the big controversy of the plan, the computer replacement, and as one of the gentlemen pointed out earlier, there is really no clearcut decision technically. It is agreed that something has to be done.

The proposed system, going to the host computer, in talking to my experts is certainly a valid solution and the one we would recommend. A concern of mine personally is the lack of concern about the computer software. It was mostly given lip service until the panel started here today, and it began to come out that the management of the software development is probably of the most concern.

Regardless of what path we take, one thing that has not been said is we currently have a software system that is currently working. It has taken many years to get there and to say in a few years we will throw that away and put in an entirely new system, is more difficult than I think is appreciated.

So from just that one viewpoint, going in the interim to a host computer to salvage as much of the existing software as we can, is I think the overriding factor in the decision.

Senator KASSEBAUM. And you feel it is sound?

Mr. MARTIN. Yes. Any approach can be made to work, but I agree wholeheartedly that a very determined management system, especially in the management of the software development, is absolutely necessary.

Senator KASSEBAUM. Do you feel the replacement sequence and the sectors approach minimizes any risks during transition?

Mr. MARTIN. I think so, yes.

Senator KASSEBAUM. There has been question, you know, that the sectors approach——

Mr. MARTIN. Yes. I think the alternatives have more risk. It is an opinion, hard to justify, and we have not done the detailed analysis the Government agencies have. But what data has been published we reviewed and we have no argument with it.

Senator KASSEBAUM. Mr. Howell, you mentioned in one of the 11 points in your concern the central flow control. I am really not that familiar with Mr. Helms' facts on that or the FAA's. Is there disagreement with the FAA's approach?

Mr. HOWELL. We think that the central flow control, which attempts to eliminate delay by holding aircraft on the ground at originations which are perhaps thousands of miles away from destinations, is inappropriate. There are too often times that when flow control is in effect you will arrive at the airport and experience absolutely no delay due to conditions and their improvement, even to the extent that you will be asked to speed up and go in.

So our thoughts are that we have done entirely too much strategic or advanced planning with central flow control, and instead we need to take a more short-term view of conditions at the destination airports which are affected by adverse weather conditions.

Senator KASSEBAUM. I guess I had not realized this was an aspect of the NAS plan that was—is it?

Mr. HOWELL. Let me try another tack. The general term that we are striving for in using the airspace as a national resource is preserving as much operational flexibility as is feasible in any of these automated programs, so that we minimize delay.

Senator KASSEBAUM. And you are just laying this out as a concern you have, but this is a procedure now being followed which will perhaps be followed even more rigidly?

Mr. HOWELL. More rigidly.

Senator KASSEBAUM. In the future.

Mr. HOWELL. That is our fear. We would like to move away from that philosophy.

General VON KANN. I must say, if I understand the plan—and I do not think any one of us understands every aspect of it—it is the objective of the plan to move in just the direction Captain Howell wants to move.

Senator KASSEBAUM. Without being so rigid?

General VON KANN. Yes.

Senator KASSEBAUM. I would think so. That is why I was a little startled. I had not heard that raised before, and I would think that that would be the direction in which everyone would wish to go.

Is not part of the problem right now, of course, the burden posed because of the shortage of air traffic controllers?

Mr. HOWELL. Very definitely, that short-term effect is taking its toll.

Senator KASSEBAUM. Mr. Howell, do you think the plan has adequately addressed the tradeoffs between automation and human participation in air traffic control? And if not, what additional work needs to be done in that area?

Mr. HOWELL. In a word no. I think we need to do more work in the area of the integration of the human into the automated system. We are habitually very poor managers over long periods of time. We need to be interactive with the automated systems, and I think the FAA needs to actively pursue programs which will help

them identify the reasonable levels of human intervention in the automated processes.

Senator KASSEBAUM. Did you hear earlier the testimony regarding the National Airspace Review Board? I would like to ask all three of you, and General von Kann as well, what your thoughts were on some, evidently, misunderstandings about the direction of the board and what the board is indeed supposed to do.

General VON KANN. Yes. We do not have a participant, but we do get information. And my understanding was that the airspace review process was to do just about what John Ralph described, in other words to develop the procedures and other practices to bring the new system and the new hardware into the implementation phase.

And if it is not doing that, I think this is something which the Administrator himself is going to want to look into, and I am sure he will. I have a feeling, since the process has only been going on for about 2½ out of 40 weeks, it is still in the shakedown phase.

I am sure the objective is not to rehash the problems of the past, but to cope with what lies ahead. And I am sure it will develop that way.

Senator KASSEBAUM. I had thought of that question really in the light of your comments, Mr. Howell, about the better integration you felt between the human and the computer factors. And I wondered if this was not a logical aspect that would be under review.

Mr. HOWELL. Yes, we are participating in the national airspace review, and it is our opinion that it is quite a bit separate from the NASP. However, with respect to the members we send to the NAR meetings, we are making sure that they are very much aware of the elements of the plan so that in the airspace review they can be sure that what results from the NAR does preserve the flexibility in the airspace to accommodate the automation and improvements embedded in the plan.

We agree, there is some plowing of old ground. But the program is still in its early stages and we need to establish some common grounds often for all of the members before we advance. It is a viable forum for what Administrator Helms this morning said is an "active dialog."

And one minor criticism that we have is that we are not getting sufficient access to the formulation of the agendas for the meetings, but we are working on it.

Senator KASSEBAUM. Any comments the rest of the panel would like to make?

Thank you very much. I appreciate your testimony this morning.

That concludes this morning's and this afternoon's meeting.

[Whereupon, at 1:05 p.m., the committee was adjourned.]

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